

# Intellectual Output 2

Guidelines for Singers, Vocal Coaches / Continuo  
Players, Directors, Choir & Orchestra Conductors

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### Guidelines for Singers, Vocal Coaches / Continuo Players, Directors, Choir & Orchestra Conductors

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# 1. Introduction

These Guidelines provide a detailed overview of the state of the art in remote teaching and training in the field of opera, with particular focus on the teaching activities of singers in which the other figures of reference are involved – orchestra conductors, choir directors, vocal coaches/continuo players and directors. We have analyzed the different approaches at various stages: before, during and after the pandemic. In order to pursue this objective, we have based not only on the direct experiences of the partners involved in the Virtual Stage project, but also on an accurate survey via questionnaire addressed to more than 300 representatives of the sector (academic institutions, theaters, festivals, music associations, music schools, opera and baroque singing teachers, instrumentalists etc.) operating throughout the European territory.

The evidence shows a series of problems and needs, arisen during the pandemic, that can concretely open up to new opportunities beyond the specific emergency period. In other words, the search for alternative solutions represents a new digital paradigm with immense application potential for the whole sector, as well as a significant enhancement of good practices deriving from the contribution of technologies applied to musical activities (teaching, professional training, performance, recording etc.).

## 1.1 Lockdown experience

Before the lockdown restrictions, teaching and training in the field of opera were held almost always in presence, with little support by technologies.

What kind of technologies are we talking about?

Certainly not the technologies applied to the recording and transmission of musical activities and events that are usually present, starting from the last century, in the panorama and in the culture of the musician; the past months, which have prompted many people to search for new solutions, have revealed how technologies related to (social) networking and the self-processing / output of musical products were not part of the heritage of the classical teacher / musician.

We emphasize the term "classical musician" because the support of audio-video technologies is normally used in the context of pop music, jazz, etc.

Until the breakout of the COVID-19 pandemic, all the preparatory stages of the opera (learning, rehearse, practice, stage presence, costume and scene setting etc...) were undertaken in presence and people were

used to meeting in large groups, working together for several hours, in long sessions that involved a considerable organizational and economic effort.

So, when we all found ourselves suddenly thrown into the pandemic era and the consequent restrictive measures, it became immediately clear that the learning and training activities in opera, as we had practiced them up to that time, were over.

Here a summary of the main problems we had to face:

- no access to live performance venues;
- very often there was a suspension of orchestral and choir rehearsals, etc.;
- very often the hiring of workers in the sector has been severely reduced: directors, set designers, technicians etc.;
- in most cases it was not possible to attend music lessons in presence;
- the approach to the NMP (Networked Music Performance) – due to synchronization problems – has been mainly theoretical;
- extreme difficulty in carrying out face-to-face auditions, tests and assessments.

## 1.2 The first response to the emergency

The musical world reacted to the crisis through a series of immediate technological solutions such as online meetings, NMP, streaming concerts and sometimes even a sort of synchronous activities, trying to test new possibilities for "playing together", also thanks to the experimentation of new apps and audio tools.

It is undeniable that financial resources reserved for culture are fewer and fewer, while costs for supporting the realization of the activities are increasingly higher. In order to invert this trend, new cultural policies are needed as well as considerable investments on the artistic and cultural sector. Besides that, it is possible to have strong support from technologies applied to teaching and professional training and, if possible, also to the performance in the opera sector.

This will have a positive impact in containing costs and above all in their optimization, with a clear improvement in the cost / performance ratio.

The goal of this project is to create a generation of new classical musicians who know how to use most of the great opportunities offered by new technologies. At the same time, the project aims to stimulate teachers to use technologies in a functional way, so as to increase all teaching activities and sharing of procedures and best practices.

### 1.3 Why are we talking about opportunities?

Starting from national and international experiences on how to deal with this new and unprecedented reality, in which face-to-face meetings were not possible or at least strongly limited, the challenge is to design and propose some effective procedures that teachers of musical institutions can apply to enhance and expand their teaching activities. It might seem too optimistic, but we think that several problems can be turned into opportunities.

The Virtual Stage work group has included into this project the various experiences gained during the months of lockdown, aiming to transfer what was initially an emergency need into a stimulus to increase digital skills not only in teaching and training, but also in the performance.

This analysis finally led us to consider how much these technologies could bring benefits to final users: students on one hand and audience on the other.

### 1.4 List of needs encountered during the stop of the activities in presence

We believe that all teachers of conservatories, music schools, operatic institutions and festivals etc. have got the need to continue to:

- give indications on the performance criteria;
- give indications on the interpretation criteria;
- assess students' performance and learning progress;
- rehearse in groups;
- work together, with regard to different roles and matches: singers and vocal coaches, singers and choir & orchestra conductor, singers and director;

But how to deal with these new needs?

### 1.5 The experience we built on

Two main elements were taken into consideration and analyzed as follows.



### 1.5.1 The Survey

Since it was necessary to broaden our view beyond the team of researchers involved in the VS project, a survey was carried out that allowed us to investigate some aspects related to the use of digital tools in the world of classical music at European level, specifically in the opera. To do this, we created the multilingual questionnaire which is described in the Output 1 (IO1) report, and which served as a further stimulus and study for the creation of these Guidelines.

### 1.5.2 The first project phase

Finally, a third element is linked to the work and discussion group that took place during the first phase of the project, including the Joint Staff Event held in October 2021. The group of experimenters / researchers was in fact divided into smaller groups: Singers, Vocal Coaches / Continuo Players, Directors, Choir and Orchestra Conductors.

The division into small sectoral groups offered the possibility to plan an important remote interaction for the following months, in order to significantly develop and deepen the project's research areas.

The groups have identified, each for their own area, a list of needs, problems, criticalities encountered during the emergency period, but more generally they questioned about how their activity can take advantage from a more widespread use of technologies.

All these aspects will be discussed in the following chapters.

## 2. The approach of Virtual Stage to IO2

The evolution of technology and the consequent increasing speed of digital communication networks allows to improve the communication experiences with the dramatic reduction of the virtual distances.

The EU funded project Virtual Stage aims to develop and improve tools for distance learning of music and to collect such tools in integrated remote environments for music interaction and education. Within the project, we have chosen two techniques for distance learning: Partial Playback (PPB) and Networked Music Performance (NMP). These two techniques require the use of hardware and software tools.

The goal of this document is providing comprehensive guidelines for time and cost-effective rehearsals for singers (soloists and choir), choir conductors and accompanists (piano and continuo) by using network technology. Two strategies were developed for synchronous learning:

- 1) Networked Music Performance (NMP) - real time rehearsal with limited sound quality;
- 2) Partial playback (PPB) - recorded soundtrack for training sessions (no real time, but good sound quality).

The team of Virtual Stage assume that, when NMP is too difficult to achieve (poor network quality), PPB is a good alternative in order to provide audio material for online practical courses. Since the goal of Virtual Stage is to make practical online courses possible for opera training, a wide range of techniques (other than NMP and PPB) are required for best results. This includes online tools for translation, interactive scores, Digital Audio Workstations (DAW) and virtual environments for staging. Also, the making of an opera or any similar musical theater involves a wide range of professionals. IO2 document provides comprehensive guidelines for singers, choir directors, piano accompanists and continuists.

There are 5 individual parts:

- Singers
- Choir conductors
- Piano accompanists and continuo
- Stage directors
- Software and hardware.

## 2.1 Choir Conductors

The following description of the experience of Virtual training for choir singers describes a mere preparatory stage, where the activities were conducted as a preliminary work before the actual work of the ensemble in presence. In the researchers' opinion it is not possible to skip the final stage of work in presence, in order to conduct a good training program.

Some parts of the preparation work for the choir singers, mostly the ones concerning the analysis of the text and the diction and pronunciation lessons, did not really suffer degradation in distance learning. The online meeting, actually, gave the teacher some extra possibilities to make the work more efficient:

1. sharing on the screen the scores and add notes and marks online, so that the students could save those files in the form of a personal study archive;
2. sharing videos with explications of the text articulations, so that the students could watch them again during their individual study at home;
3. translations line to line of the text in various forms to let also the international students fully understand the explication of the teacher through interactive work more efficiently realized with the digital tools
4. guided listening to audio/video recordings with a final discussion from the group of students.

Yet, the most difficult moment arrived when the group of students had to exercise the ensemble singing. The use of digital tools to minimize the latency (*Jamulus*) helped the group to experience online the possibility to sing together and the teacher could give some important lessons on the comprehension of the conductor's gesture. Although the work with a smaller group of voices showed some improvement, it was quite clear that the online session had also a very important limit: the isolation of each choir member in his/her home did not produce the necessary effect of listening to each other, as in presence, and the concentration only went to some mere "following the group" task rather than a full interaction with each other. Not to mention the extreme difficulty to create phrasing, dynamics and colors since the final sound result produced by the digital tools gave a very small range of variations.

Therefore, the online experience worked with a generally satisfactory evaluation only in the PRELIMINARY stage of work before the actual realization in presence on a later stage.

## 2.2 Singers (choir members)

Problem	Traditional Solution	Networked tech enhancement	Tools
1. Phonetics and Diction	Study of articulation and pronunciation exercises with detailed approach, with explanations and direct showing by the teacher: the pupil tries to imitate and the teacher makes corrections. <i>Rhythmic reading</i> of the texts following the structure of the melody.	Slides with theoretical explanation on International Phonemic Alphabet (IPA)  Audio recorded demos by the teacher with high quality sound  Demos of the student's exercises to be analyzed and verified by the teacher  Video conference as lesson	PowerPoint or similar  Pdf or similar  Audio and video recording devices (high quality) with good microphones  PC/Laptop/Notebook/ Ipad, etc. with applications for video-conference (such as Zoom, Google Meet, Teams, etc.)
2. Interpretation of the poetic line	Translation and explication of text, with references to the historical period and the biography of the author, with explanations directly by the teacher: pupils listen to the teacher and make questions.	The same, enriched by: <ul style="list-style-type: none"> <li>– sharing notes, schemes, slides (IPA);</li> <li>– file audio with text recitation.</li> </ul>	The same as here above.

<p>3. Technical approach (vocal technique, body posture)</p>	<p>Technical vocalization, voice warming, technical vocalization, with explanations and examples by the teacher; sometimes correction through touching the student's body (shoulders, head, arms...): pupils tried to imitate and teachers made corrections.</p>	<p>The same, but without the possibility to touch parts of students' bodies, only showing and correcting them, through the teacher's posture or singing examples. Possibilities to use anatomic pictures, notes, schemes and so on.</p>	<p>The same as here above.</p>
<p>4. Musical interpretation (words combined to music, style praxis and score analysis)</p>	<p>Analyses of the score and extrapolation of musical elements, related with the meaning of the text (rhetorical figures); singing exemplifications and parallels with other compositions by the same composer or by other contemporary authors.</p>	<p>The same, but also with shared slides with theoretical explanation (IPA) Audio recorded demos by the teacher with high quality sound Demos of the student's exercises to be analyzed and verified by the teacher. Video conference as lesson.</p>	<p>The same as here above.</p>

<p>5. Comprehension of the gestures of the Choir master / Conductor</p>	<p>Study in presence with the various singers and choir sections; rehearsal in various combinations, looking at the gesture of the conductor, understanding his asking/indication about agogic, dynamic and musical phrases in general.</p>	<p>Online the conductor has to explain his gesture and make examples, while singers are singing and players are playing; but if many people are involved in the rehearsal online, it's quite difficult to follow the conductor master, because of the delay of other voices/instruments.</p>	<p>Audio and video recording devices (high quality) with good microphones</p> <p>PC/Laptop/Notebook/ Ipad, etc... with applications for video-conference (such as Zoom, Google Meet, Teams, etc.)</p> <p>In this case it could be a great improvement to make rehearsal with a platform like Jamulus.</p>
<p>6. Consciousness of Ensemble working</p>	<p>This part of the study is the most appropriate in presence: for instruments and singers but also for a single choir. While singing or playing, hearing other people playing makes us conscious of sound equilibrium (dynamic, intonation, agogic, and so on).</p>	<p>This kind of work is the most problematic to do online, because of the delay. <b>Players and singers can only practice approximately, paying attention NOT to hear each other: the exact contrary of the main aim and of the required skills in presence.</b></p>	<p>Audio and video recording devices (high quality) with good microphones</p> <p>PC/Laptop/Notebook/ Ipad/ etc. are very useful.</p> <p>Applications for video-conferences (such as Zoom, Google Meet, Teams, etc.) are quite insufficient; it's better to make rehearsals with a platform like Jamulus, which</p>

			reduces delay to the minimum.
7. Character interpretation, text dictions	IPA practice is normally used for text diction.	Working on a video platform online with diction coach/stage director.	Audio tutorials with right pronunciation/diction realized ad hoc from a mother language coach for the specific cast.
8. Acting skills: stage movement	Rehearsals 100% in presence.	Sharing staging notes realized by the Stage director.	Working with tools such Mirò with avatars of the characters acted on the PC directly by the singers

## 2.3 Keyboards (vocal coaching/continuo)

Problem	Traditional Solution	Networked tech enhancement	Tools
Pitch transposition	Knowledge and practice: tone up and down, 3rd maj and min up and down, half tone; re-writing	Digital keyboards, score editing with transposition	Sound card Computer Tools (Reaper, Kontakt)
Orchestra or Choir reduction	Handwritten transcription on pentagrammed paper	Music notation software (Sibelius, Finale and MuseScore)	Computer, tablet, MIDI keyboard

Score editing: importing and modifying low quality scores	Paper and pencil, multiple printing, glue, scissors...	Notation based editors  Score importing  Graphical based editors	Finale & Sibelius (comm), Musescore & Lilypond (free)  Repositories, OCR techniques  <a href="http://partifi.org/">http://partifi.org/</a>
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### 2.3.1 Skills and pluridisciplinary competences

The vocal coach for early music, classic opera, romantic repertoire and contemporary music is one of the most important, requested and necessary roles in the professional music world.

This professional figure must have strong skills about several aspects of music, some of them not correlated directly to the technical keyboard performance aspects. Specifically, the vocal coach must:

- know the history of music, the various authors and different styles;
- know languages (ancient and modern) and their pronunciation;
- know vocal technique and the needs of singers in opera and sacred repertoire;
- learn about the instruments of the orchestra: their technique, their sound;
- know choir life and the choral repertoire and have the ability to conduct a vocal group;
- know the technique of conducting an orchestra, have the ability to read an orchestral score and lead an ensemble;
- be able to establish an empathic connection with other musicians;
- know how to assume human and professional responsibility in a project;
- know the pronunciation specially designed for singers and vocal coaches;
- know the treaties and historical practice.

It is clear for every professional of this field (both piano accompanists and continuists) that there is no traditional pedagogical approach if by “traditional” we mean theoretical. Actually, there is no specific theoretical method for vocal coaches except some guidelines or essays that are always based on practice and the concrete application of the knowledge: and when we think about the theoretical background and the concrete competences that an accompanist needs to have, we have a very long list that can be summarized by the list above.



### 2.3.2 Filling the gap between soloist and accompanist: how do institutions prepare vocal coaches

As there is no theoretical method to shape the vocal coach it is very difficult for a soloist to acquire the skills of the accompanist: harpsichordists and organists might start this career by approaching the figured bass and that often happens in ancient-keyboardists' course of studies, for pianists this is rather difficult because in the last 100 years the two figures of the accompanist and the soloist have been gradually distanced until the last 50 years in which the two figures are completely separated and not communicating: the soloist career is built already in the early years of studies and the pianist who wants to learn the art of accompaniment has to study chamber music: a completely different course! As a matter of fact, the first official academic course of piano accompaniment will be opened in Italian conservatoires only in June 2022, while elsewhere it is already a well-structured course. The gap between soloist and accompanist is also bound to the common prejudice according to which the soloist is the quintessential pianist while the accompanist just "follows" the soloist.

This gap between soloist and accompanist has been noticed by Virtual Stage's team of vocal coaches (both ancient keyboardists and pianists) since the beginning of the project and we are positive about the enhancement of technologies concerning this problem.

In the present days institutions are focusing on enhancing the education of the accompanist in terms of:

- sight-reading
- transposition
- orchestra/choir/quartet reduction
- composition/ arrangement
- accompaniment techniques according to the different styles
- dance / theater accompaniment
- communication techniques
- psychology applied to music.

Sight-reading is one of the main abilities of the accompanist/vocal coach: it is important to underline that the ability to sight-read a piece pool together soloists and accompanists, the difference lies in what type of music we refer to. The accompanist has to embrace a large variety of styles including a repertoire that dates back to early baroque and reaches the contemporary music: this means that the accompanist needs to have "to hand" a huge variety of performance practices. An example of a sight-reading method is the well-known "Speed-reading at the Keyboard" in three volumes.

The ability to transpose also belongs both to the accompanist and to the soloist, even though it is essential only for accompanists and more specifically for vocal coaches because every singer has his/her own peculiar

vocal range and texture, while a solo instrument has a precise extension depending on its family and its range.

We are used to think that choir and orchestra reduction is mainly the accompanist’s job but if we think about Liszt’s transcription of Beethoven’s Symphonies or Bach’s organ reduction of Vivaldi’s concertos for strings (see the example in the picture below) we soon understand that the idea of the keyboard instrument as a “miniature” orchestra has its origins in the soloist’s repertoire.



Antonio Vivaldi’s concerto for two violins in a minor (RV 522) on the left and Johann Sebastian Bach’s transcription of the same concerto for organ (BWV 593) on the right.

Relative to this matter there is also the ability to compose and arrange that in this sense is a common matter of study and practice for soloists and accompanists.

The other skills listed above are totally accompanist-oriented and require a lot of time and infinite attempts before they become consolidated in a musician.

As a matter of fact, a concrete interaction with the singer/instrumentalist and the accompanist is indispensable in the accompanist’s formation and education.

Virtual Stage’s aim in the complex field concerning the figure of the vocal coach is to help him/her prepare for the interaction through network-based distance learning so that he/she knows what to expect in terms of phrasing, breaths, articulation, dynamics, voice texture and musical ideas. In this sense the keyboardist gradually learns the key-role of the vocal coach, that not only is in control of written notes/text, but also of expressivity, phrasing and musicality. Network based distance learning can enhance the new specific didactic

method for vocal coaches and accompanists allowing them to prepare for the interaction or to have a more gradual approach.

The know-how of the network-based distance learning will be further analyzed in the following paragraphs.

### 2.3.3 Network based distance learning for vocal coaches

Distant pedagogy is an area of ongoing research for each level of learning. The development of educational technology has provided platforms for undergraduate and graduate music courses to take place in an online environment. In the context of the two main methods developed in Virtual Stage, networked based solutions can be applied to the pre-professional (undergraduate level) and professional (graduate and post-diploma) training of vocal coaches, piano accompanists and continuo players.

Assuming that the two methods developed in Virtual Stage are the partial playback and the Networked Music Performance (NMP), the vocal coach/continuoist has to be equipped with a minimal set of tools and the materials for recording and transmitting the sound signal via internet networking.

## 2.4 Orchestra Conductors

### Registration of tutorials under the guidance of Orchestra Conductor

In the first phase, the teachers will make a video recording of the single part of the piece.

Thanks to the collaboration of an audio technician, the recordings will be returned with a qualitatively suitable sound and superimposed on a multitrack file that will allow to exclude the part that the student will have to perform to practice. It will be possible to slow down the speed to allow a more effective initial study phase for students.

To facilitate the work, for example in the instrumental introductions of vocal pieces or in the case of long pauses, a low volume sound guide can be created.

Furthermore, further solutions can be developed, in order to facilitate the students' practice in the different situations experienced.

### Deliver tutorials to students and use them

In the second stage, students will receive the recorded tracks. In this way they will be able to practice with greater awareness and deepen the study of the piece in a more chamber style.

The choice to make a video recording (instead of just the audio recording) will allow students to observe during their performance not only breaths, fingerings and arches, but also more easily follow the pauses, attacks and movements of the body, which "guide" them. performance of the piece.

It should be emphasized that in a preparatory phase the tutorials can also be used as a guide for one's part. Therefore, three phases could be identified:

1. listening and studying the version of the tutorial with its single part to assimilate it correctly, even practicing at the same time;
2. listening to and studying the complete version of the tutorial with all the parts, to assimilate it in its entirety even by practicing at the same time;
3. performing your own part individually using the version of the tutorial that excludes it to make yourself autonomous;
4. realization by the students of their own recording and elaboration of the final product.

In the third phase, students will be guided by the Orchestra Conductor, during the Academic Year, to produce their own recording, which will replace the track initially prepared as a tutorial by the Orchestra Conductor.

Also thanks to the collaboration of an audio technician, the tracks will be processed as described above.

If, as we all hope, it is possible to go back to carrying out teaching activities and face-to-face exams, the audio-video product created by the students can be considered to all intents and purposes a result of the training process that will integrate the musical skills acquired. This experience will bring greater skill in creation of audio-video supports, which are increasingly important in our sector today, especially for young people for auditions and placement.

If necessary, these products can also constitute elements for the final evaluations of the courses.

### **Equipment and costs**

The nature of this experimentation is to facilitate the online training process with the equipment that both Orchestra Conductors and students normally have available, without having to acquire specific equipment and incur costs. Will be enough:

- audio headphones or earphones;
- smartphone or other device to practice on the delivered multitrack file;
- smartphone and other devices at the same time (tablet, PC, etc.) to be able to listen and see the basic track and simultaneously record video.

## Repository and database

The material created can be made available free of charge on an interactive Repository such as IO4 on the type of IMSLP or a dedicated Youtube channel, which can also be freely implemented by Orchestra Conductors / professionals of other conservatories in Italy and abroad.

## Conclusions and perspectives

Interested Orchestra Conductors will be able to collaborate in the way they deem most appropriate: they will be able to make each other available for recording the tutorials of the vocal and instrumental parts and will also be able to use this methodology in whole or in part.

In the future it would be desirable to integrate the experimentation described above with recording in the presence of audio-video supports, in order to also provide more real models of the performance of the piece, which are complementary to the multitrack.

As happens in many other experiences of DaD, seminars and online conferences, this methodology can also be applied in both alternating and mixed blended modalities. In alternate mode, part of the lessons in presence and part online could be carried out, while in mixed mode, part of the students in presence and part online could be foreseen.

This flexibility could therefore make it possible to integrate the lessons and tests in the presence, rather than replace them, providing further support even for face-to-face training.

## 2.5 Guidelines for Stage directors: Historical study of a musical theater work

Since the first rehearsal, the stage director must give explanations to the singers about the historic period of the opera they will perform.

In the traditional production he meets the artists in a rehearsal room, around a table. Artists must have the score with them, and he gives to them the necessary acquaintances about the style of the composer and the period in which the stage director intends to place the plot.

It is possible to do the same work on a virtual way, using video conference App like Zoom, Meet, Skype or similar. In case of a virtual conference, the stage director gets lot of further possibilities, sharing pages of books, drawings, videos and photos, making the explanation more complete. Stage director may also prepare some graphics or visual summary by PowerPoint App.

Artists can furthermore record the explanation in order to review it during rehearsals.

Problem	Traditional Solution	Networked tech enhancement	Tools
<p>1. Historical study of a musical theater work</p>	<p>Personal study by the artists on historical texts and on the score</p> <p>Meeting with the stage director and the conductor in order to go deeply into the matter</p>	<p>Video conference as group lesson</p> <p>Slides with historical explanations, screen sharing with collective reading of the score, transmission of writings about theater works in order to print and study</p>	<p>PowerPoint or similar Pdf or similar</p> <p>Audio and video recording devices (high quality) with good microphones</p> <p>PC/Laptop/Notebook/iPad/ etc. with applications for video conference (such as Zoom, Google Meet, Teams, Skype, etc.)</p>
<p>2. Study of the subject or plot</p>	<p>Personal study by the artists on literature texts and on the score</p> <p>Meeting with the stage director and the conductor in order to go deeply into the matter</p>	<p>Video conference as group lesson</p> <p>Screen sharing with slides about literary sources, common reading of the pages of the novel, talks online about the story and how to develop it on stage. Singers can express their feeling about it and their ideas about production</p>	<p>Power Point or similar Pdf or similar</p> <p>Audio and video recording devices (high quality) with good microphones</p> <p>PC/Laptop/Notebook/iPad/ etc. with applications for videoconference (such as Zoom, Google Meet, Teams, Skype, etc.)</p>

<p>3. Translation in different languages comprehensible to the singers</p>	<p>The director prepares a translation for each singer from other languages and countries and give a copy of the translation to each one.</p>	<p>Video conference as group lesson</p> <p>Each singer during online meeting, actives translation program in order to get a translation in real time. They can copy and print it, in order to perfectly understand poetic words.</p>	<p>Power Point or similar Pdf or similar</p> <p>Audio and video recording devices (high quality) with good microphones</p> <p>PC/Laptop/Notebook/ iPad/ etc. with applications for videoconference (such as Zoom, Google Meet, Teams, Skype, etc.)</p> <p>Translation applications such as</p> <ul style="list-style-type: none"> <li>– <a href="http://www.interactio.io/w">www.interactio.io/w</a></li> <li>– <a href="http://ww.translate.google.com/">ww.translate.google.com/</a></li> <li>– WT2</li> <li>– iTranslate Voice</li> <li>– QTranslate</li> <li>– Bing Translator</li> <li>– WordReference (just for single words)</li> <li>– ImTranslator</li> <li>– InstantTranslate</li> </ul>
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<p>4. Psychological analysis of the characters</p>	<p>The stage director gives to the artists his personal key of interpretation and drives them to understand deeply what the characters have in their mind when they are singing.</p>	<p>Video conference as 1-to-1 lesson</p> <p>Video sharing with different interpretations of the same character in film, theater prose, other stage settings</p> <p>Psychological work on the character with slides by psychologists</p>	<p>PowerPoint or similar Pdf or similar</p> <p>Audio and video recording devices (high quality) with good microphones</p> <p>PC/Laptop/Notebook/iPad/ etc. with applications for video conference (such as Zoom, Google Meet, Teams, Skype, etc.)</p>
<p>5. Interaction between characters</p>	<p>Each scene of the plot needs interaction between characters. The stage director drives the singers, in the rehearsal room, to understand their mutual relationship.</p>	<p>Video conference as group lesson</p> <p>Talk about relationships between characters</p> <p>Video sharing of other productions and comments</p>	<p>PowerPoint or similar Pdf or similar</p> <p>Audio and video recording devices (high quality) with good microphones</p> <p>PC/Laptop/Notebook/iPad/ etc. with applications for video conference (such as Zoom, Google Meet, Teams, Skype, etc.)</p>



<p>6. Acting and interpretation techniques</p>	<p>The stage director helps the artists to interpret their own character by voice, acting, moving and by their posture.</p> <p>The stage director makes examples in a special rehearsal room and wants the singers to repeat the same.</p>	<p>Video conference as group or 1-to-1 lesson</p> <p>Exercises of acting techniques online with singers</p> <p>Full body or face vision. Study of the expressions</p> <p>Filming of the exercises and following collective analysis of the result</p>	<p>PowerPoint or similar Pdf or similar</p> <p>Audio and video recording devices (high quality) with good microphones</p> <p>PC/Laptop/Notebook/ iPad/ etc. with applications for video conferences (such as Zoom, Google Meet, Teams, Skype, etc.)</p>
<p>7. Make up preparation according to characters and historical period</p>	<p>Even if production usually gets a special worker to make up artists before performances, they have to know make up technique because it could happen they have to do it by themselves. In any case, they know their face and expressions better than any other.</p> <p>The stage director explains how is the best make up for each character and they try to reproduce it on their own face.</p>	<p>Online study of makeup for theater using programs and applications for the makeup of the photos. Color shades, hair color, makeup lines, characterization. The singer can see the effects on his own photos.</p>	<p><a href="http://www.artandmakeup.com">www.artandmakeup.com</a> makeup course for theater</p> <p><a href="http://www.timelessbeauty.it">www.timelessbeauty.it</a> history of stage makeup</p> <p><a href="http://www.teatropertutti.it">www.teatropertutti.it</a> tutorial</p> <p>Modiface MakeUp App</p> <p>Youcam Makeup App</p> <p>B612 MakeUp App</p> <p>Perfect365 MakeUp App</p> <p>FotoRus MakeUp App</p>

			<p>MakeUp Genius MakeUp App</p> <p>MakeupPlus Makeup App</p>
<p>8. Costume's study according to characters and historical period</p>	<p>In a special meeting, the stage director explains his idea about costumes (according to the historical period or not) and gives to the artists their stage costume in order they can get accustomed to wear it. Costumes are usually created by professionals.</p>	<p>Online the artists can see their stage costumes created by professionals and try combinations of clothes and tools, studying the final effect even before the creation of the costume itself. They can also prepare themselves for the changes during the show.</p>	<p><a href="https://smart-pattern.com.ua/en/valentina/">https://smart-pattern.com.ua/en/valentina/</a></p> <p><a href="http://Tailornova.com/designer">Tailornova.com/designer</a></p> <p><a href="https://iridedilucecoeva.wordpress.com/storia-del-costume/il-costume-teatrale/">https://iridedilucecoeva.wordpress.com/storia-del-costume/il-costume-teatrale/</a></p>
<p>9. Stage setting and stage tools: interaction singers-tools. Singers movements on stage.</p>	<p>Each artist must have a relationship with tools on stage. He must know when to use it and how. The stage director shows to the singers how to use tools during rehearsals and what the stage setting represents.</p>	<p>On online rehearsals, the artist moves an image of himself (token) in a virtual space, so that he can memorize that he has some tools and he must not forget them. Vision tries to substitute direct experiences and repetitions help memory.</p>	<p>App for virtual staging, such as MIRO or OWLBEAR.RODEO that allow sharing of a virtual scene. Each singer can move his image from his house on his own computer and it works on all the singer's computers.</p>

<p>10. Interaction singers-orchestra</p>	<p>Stage musical performances have to observe a strong relationship between singers and orchestra. During rehearsal the stage director drives singers to choose the best position in order to sing and see the conductor.</p>	<p>This is the most difficult point. Singers have, online, a map of the stage on which they move an image of themselves, but they see the conductor in a lateral screen that doesn't have the same position of the real conductor on stage. So they have to memorize music and dynamics, but they will have to see the conductor in case of a real performance.</p>	<p>Audio and video recording devices (high quality) with good microphones</p> <p>PC/Laptop/Notebook/ Ipad/ etc. are very useful.</p> <p>Applications for video-conferences (such as Zoom, Google Meet, Teams, etc.) are quite insufficient; it's better to make rehearsals with a platform like Jamulus, which reduces delay to the minimum.</p>
<p>11. Production on stage</p>	<p>In the final rehearsals, everything must be at its place: orchestra, artists, costumes, make up, setting, tools. Artists do some rehearsals very similar to the show to get accustomed to doing everything following the stage director's notes.</p>	<p>Artists must behave as if they have rehearsed on a real stage. Their memory must drive them to the best result.</p>	

<p>12. Making an Opera film</p>	<p>The stage director films with professionals the performance made on stage. Everyone is playing or singing "live". At the end the stage director chooses the best film shootings on the basis of music or scenic result.</p>	<p>Online the conductor and the orchestra make a complete sound recording of the opera. Then the stage director moves singers to a virtual space creating visual effects. Then on film editing, he composes a visual word very different from a real theater performance.</p>	<p>High quality cameras and film editing programs</p>
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### 2.5.1 Study of the subject or plot

In the same way the stage director must give to the artists the necessary acquaintances about the origin of the subject, if it has been taken from a novel, or a poetry, or it is completely original. Then he explains to them how the original text has been adapted to the music, what has been cut from the original plot and how are the characters.

This can also be done in a virtual way using video conference App like zoom, meet, skype or similar. In case of a virtual conference, the stage director gets lot of further possibilities, sharing pages of books, drawings, videos and photos, making the explanation more complete. Stage director may also prepare some graphics or visual summary by PowerPoint App.

### 2.5.2 Translation in different languages comprehensible to the singers

Usually, singers are coming from different countries, so the stage director has two possibilities: do not give importance to the fact the artist understood the text or not, trusting in their professionalism, or to want to control their level of understanding, asking them the translation. Also during the brain-storming in the rehearsal room, the director must be sure that what he said has been understood by the audience. He can prepare a writing with the translation of the text and give to them, but he has to be understandable during explanations.

In the virtual stage this problem is solved. Artists can prepare on their device a Translator and translate the text and what the stage director says, immediately or later, by recording the explanation.

They can choose between lot of good applications.

### **WT2. (ANDROID, iOS)**

WT2 a Timekettle simultaneous translator that provides a real-time translation of what is being said by other people. In essence, these are wireless earphones which, thanks to the power of artificial intelligence, allow for a real-time translation of what is said in 36 different languages, with the support of 84 different accents and state-of-the-art technology. It has a reduction of environmental noise (which means having a very high success rate in translation). Easy to use, it doesn't need a particular configuration, just to install the app on the smartphone.

### **Google Translator (ANDROID- iOS and online for computer)**

It's the best translator in mobile's field. It allows to dictate a phrase and translate it immediately. All the same on computers.

### **iTranslate Voice (ANDROID- iOS)**

Voice input version of iTranslate, one of the most advanced and popular translation apps for smartphones and tablets.

### **QTranslate (Windows- MacOS)**

Qtranslate is an App to use on the computer and allows to translate any text selected with the mouse by pressing a simple combination of keys on the PC keyboard. It supports all major languages in the world and uses the best translation services available online, such as Google Translate and Babylon, for its translations. Consequently, it must be connected to the Internet.

### **InstantTranslate (MAC)**

Translator for computer, it allows to translate any text selected with the mouse quickly and easily.

## **ONLINE TRANSLATORS**

- DeepL
- Google Translate (online version)
- Bing Translator
- WordReference (just for single words)

- ImTranslator

### 2.5.3 Phonetics and diction

For artists is important not only to understand the text, but also to pronounce it in a right way.

On this purpose, the stage director helps usually conductor's work, by correcting every mistake about pronunciation during reading rehearsal, when the singers read the text without music, just to go deeply inside the understanding of characters and text.

This work can be made also online, in 1 to 1 or group lesson. Artists must have a good device with good microphone, and he reads the text, listens to corrections by the director and corrects his pronounce. He can also record the text read by the director and listen to it during rehearsals time. Director can prepare Power Point Slides with theoretical explanation (intense use of the IPA International Phonetic Alphabet).

### 2.5.4 Interpretation of the poetic lines

When artists understand the text and they know how to pronounce it, it's time for another step. How must these words be sung, be interpreted, be lived by the singer during performances? What does these words mean (in a clear or hidden way)?

That's the beginning of the staging. The artists have to concentrate about themselves as characters in a plot, in a time and in a different place.

In this phase the director drives the singers to understand the reason for which their characters are telling these words or singing in a love, or angry, or painful (and so on) way.

This work can be done online in a 1 to 1 or group session; it's a brainstorming in which singers face what the director means and can express their feelings. Director can prepare Power Point Slides with theoretical explanation and share them with artists.

### 2.5.5 Psychological analysis of the characters

Next step of the preparation is the analysis of the characters not only in function of the plot, but in order to understand all their psychology and to understand their unspoken.

The director explains all this theme to singers, asking about their meaning and feelings.

This work can be done online in a 1 to 1 or group session; it's a brainstorming in which singers face what the director means and can express their feelings. Director can prepare Power Point Slides with theoretical explanation and share them with artists.

### **2.5.6 Interaction between characters**

Characters don't act alone in the plot. Singers have to know how to interact with the others in order to interpret the performance at the best level as far as they can.

The director explains to them what kind of relationship they have with the other and how to act in a way to make it clear for the audience.

This work can be done online in a 1 to 1 or group session; it's a brainstorming in which singers face what the director means and can express their feelings. Director can prepare Power Point Slides with theoretical explanation and share them with artists.

### **2.5.7 Acting and interpretation techniques**

In traditional productions, the stage director gathers all the singers in a bigger rehearsal room and begins to show to them basic techniques for acting with examples. He drives artists to feel their body by yoga and gym exercises and explains to them general stage situations or how to express a feeling by a movement, a grimace, a look and so on.

This is the part of the production more difficult to reproduce online. The imitation of what the director does, of his expressions and movements can hardly be seen on the screen and also the exercises can't be properly done without seeing and feeling the other singers.

In any case we can do experiments of this on videoconference apps try to have a good, large screen in order to see easily the others. The director can also use videos, photos and texts to explain better the matter.

### **2.5.8 Makeup of the singers**

In the traditional way to produce a theatre performance, some professionals, such as make-up artists and hairdressers, study with the stage director how to make-up the singers according with the period in which takes place the plot. Then they produce some drawings in which they try to do as far as possible what the

director asked. Finally, they have make-up rehearsals with the artists, in order to see how their ideas look good on the artist's face and hair.

In the virtual stage, the first step is the same: the director asks some professional for one typology of make-Up and hairdressing which he considers the best for characters. They try to reproduce his idea not by drawings, but by virtual Apps. Singers send to them a photo (or more) and they work studying on this photo show to change makeup on their face.

A new chance is given by the fact the artists can try themselves to find the best makeup for them by experimenting on the Apps and then to present the result to the professionals.

In the last case, artists can themselves realize its own makeup, without getting professionals into the production.

In any case, virtual way allows to have photos of the artists with make-Up since the first rehearsal and this fact can help a lot the costume designer to make the best costumes for them.

### **Modiface MakeUp (Android / iOS)**

It's a photo makeup app to install on the smartphone or on Android or iOS tablet. It is a free solution that allows to try makeup on singers' photos and test over 2,000 cosmetic shades. It allows to change the cut and color of the hair; to apply a foundation to singer's face; to select a lipstick to apply to their lips; to apply mascara to their eyes or adopt a look that can make the singer look like (as far as possible) a defined character. Of course, it allows to save the finale image of the singer with the best makeup.

### **MakeupPlus (Android/iOS/Windows 10 Mobile)**

Another photo makeup app that allows to put lipstick, mascara, foundation and so on on the singer's photos. It allows to regulate the intensity of the makeup by using the adjustment bars that appear on the screen and to save the photo on the device.

### **YouCam Makeup (Android/iOS)**

It's a photo makeup App allowing to apply filters and make-Up to singer's photos (both those in the gallery and those taken at the moment), this app allows to change haircut and color. It allows to put on the singer's photo makeup elements such Lip gloss, Lashes, Eyebrows, Eyeshadow, etc., and use the adjustment bars on the screen to adjust their intensity.

By this App it's possible to view the face before and after using make-up and it gets also some more details on the type of trick you used and allows to change a certain parameter. You can save the final photo.



### **Makeup Genius (Android/iOS)**

Makeup Genius is an application developed by L'Oreal Paris, the well-known brand that has been operating in the cosmetics and beauty sector for years. Makeup Genius can be downloaded on both Android and iOS devices and allows to apply different make-up styles to singers' face that enable the user to choose the most suitable makeup for their features and, of course, for their tastes.

Some more Apps:

- B612 (Android / iOS) - this app allows to apply numerous make-up styles to both photos already saved on your device and those taken in real time;
- FotoRus (Android / iOS) – Another App that allows to virtually make up a face;
- Perfect365 (Android / iOS) - this application allows to virtually experiment with various Make-Ups on singer's face.

In order the singers to know about history of the makeup and Hairdressing, necessary acquaintances in order not to plan Makeups out of the period style of the performance, the stage director (or his assistant for Makeup) is supposed to give some history of Makeup lessons, using Zoom (or other) videoconference App, sharing on the screen pictures illustrating different make-Ups in the story and using specialistic Apps such as:

- [www.artandmakeup.com](http://www.artandmakeup.com)
- [www.timelessbeauty.it](http://www.timelessbeauty.it)
- [www.teatroptutti.it](http://www.teatroptutti.it) tutorial

### **2.5.9 Costume's study according to characters and historical period**

Costumes of a theater production are usually created by professionals who base the work on the meaning and willing of the stage director. In some case they are rented by a specialistic House.

Real costumes need of course to fits to the singers, so they need to be adapted on their bodies. At the first meeting with the director, singers are traditionally sent to costume laboratory and tailors note their body measures. Then tailors make adjustments and singers are called for a costume rehearsal in the laboratory. If everything is ok, they will have the costume ready for the last rehearsals before the première.

A professional costume designer is accustomed to use paper and pencil to draw his costumes, but nowadays, with technology advancing more and more in all sectors, we can combine the pencil and paper with any computer, on which it is possible to design fashion clothes with very refined and precise drawing or fashion

design programs (in many cases even faster). We need for this to have a graphics tablet, because mouse is not so precise like the hand, in drawing.

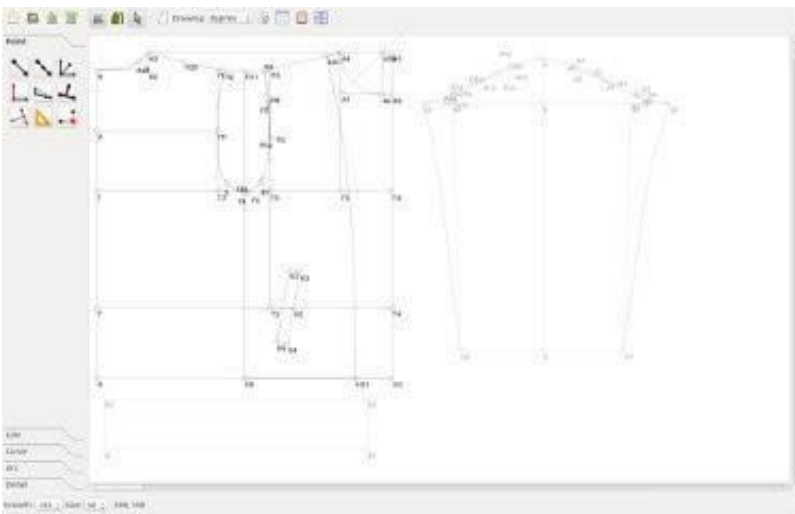
As for makeup study, also in costume art singers must have acquaintance of the style of each period of the history and so they will get classes by the stage director or the costume designer in order to know exactly what is right and what is wrong about the period chosen by the director for the production. Classes are done by zoom videoconference App (or similar) by sharing pictures and texts and video of other productions of the same opera.

Then singers can try to create their own costume by using a specialist App, like

### **Fashion Design Sketches (Windows 10)**

By this App, singers and professionals can try to create a new outfit, in case of modern production, using predetermined models. Drawings can be saved and printed.

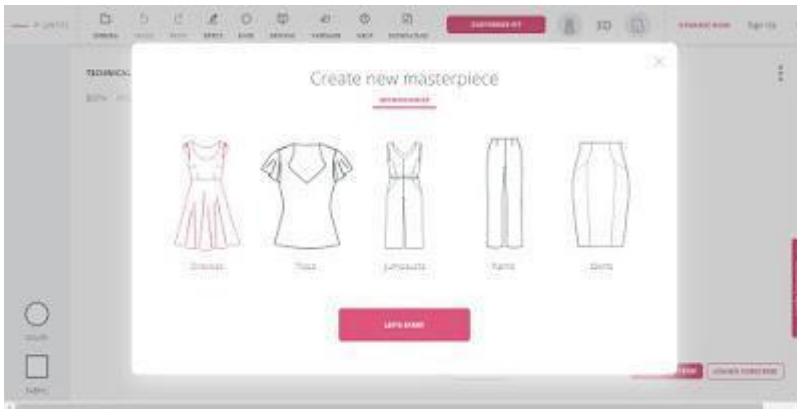
### **Valentina (Windows 10- Mac- Linux)**



Open source allows an easy and free drawing, without model to choose, so it fits also for old period costumes. It allows to choose colours, style, motif, fabric texture and so on.

With this app we can save and print illimitate models.

### Tailornova (online directly on the site)



This webapp works on all modern browsers (on any operating system) and provides ready-to-use design templates, so it allows just to modificate pre-made models, not to create freely.

Among other things, this site allows to examine the 3D clothing samples and the model on virtual paper, so as to be able to obtain projects very similar to those available in fashion houses. It works just for modern production.

### Blender (Windows 10, Mac and Linux)

Only for professional it exists a professional App, difficult to use for beginners. It's a 3D modeling program with which to "give life" to the clothes we make, downloadable from the official website.

This open-source program allows to work on 3D human models and dress them with clothing and clothing models, designed directly within the program or imported from other clothing design programs. It is necessary to have done specific courses of study or have learned the fundamentals of 3D drawing.

At the end of the tiring work with Blender it is possible to save the project with a dedicated extension or send the model to the printer.

### 2.5.10 Stage setting and stage tools: interaction singers-tools. Singers' movements on stage

In the traditional productions, next step is stage rehearsal in the place where is supposed to take place the performance. The setting is built and located in this place, with tools necessary to the story. Singers have to feel distances between the elements of the set and the tools, to know and memorize positions of the other artists. So, they do week of rehearsals to study the staging, before the "Assieme" rehearsal (Orchestra and stage together rehearsal)

It is very difficult to have the same result by rehearsing in a virtual way; the artists never meet each other, they can see the setting and the tools just on the screen and they don't know nothing about distance between elements. Knowing this distance is very important because singers must know they have a music to respect and a time determined for moving on this music. They can't know on which note they have to start movement to get in time where they are going to make some action.

To solve partially this problem, we can use virtual Apps born for position games, such as MIRO, which is a diagram creator and a display blackboard. Locating the stage image on this App and putting on it images of the singers like token, we can study stage movements. Each artist can interact with this blackboard, moving his own token on the blackboard at the same time of the others. We can also locate on virtual stage the tools necessary for staging.

The singer can memorize his own positions and note them on his score, or even take notice of a tool, note that he has to pick it up and when he has to bring it out. Singers can fix positions by screenshots.

Simpler, but easier, is the App Owlbear.rodeo, that we can use in the same way.

### 2.5.11 Interaction singers-orchestra

In traditional productions, on the Assieme rehearsals and on the general rehearsal singers have to study also the way by acting to see always the conductor in order to be on time with the orchestra. They know where the conductor is and they must provide to see him also when they are back to the audience.

In virtual staging, this is an unsolved problem. In effect the conductor is not on stage in virtual stage, but he is home on his computer and singers see him on the screen. Furthermore, they have to make music through a platform which can reduce the latency, such as Jamulus.

This platform allows singers, conductor and orchestra to be almost on time, but it is an audio transmission of the sound, so that we have to face a latency between audio (Jamulus) and video (Zoom or similar). Singers have to control lot of things at the same time: they have to see the conductor who is moving later than the sound, to control to be on time with the sound of the orchestra and to move their tokens on stage on time. Very difficult but possible, if singers know the musical role in a good level.

They have to memorize all the musical and stage solutions and remember them for the performance.

Of course, they can't calculate exactly the time necessary to reach to stage or the dressing rooms, the time to change costume, as they don't have real costumes and tools and distances.

### 2.5.12 Production on stage

The final performance is done on the traditional way. We have just made rehearsals in a virtual way. Singers and orchestra never met themselves before. They have to realize what they have studied and remember stage positions and acting on time with the music.

### 2.5.13 Making an Opera Film

On this project we made an Opera Film of Monteverdi's Orfeo. It was a complete virtual project. Orchestra made the soundtrack with singers and online instruments. The soundtrack has been completely created with sound professional programs. Then the stage director created the movie, by filming short videotracks in different places according to the plot but with a modern vision of the story. Finally, he joined the short videotracks with the soundtrack, helped by professionals.

We used to film Canon Mark III FULL FRAME and PANASONIC LUMIX. For Film Editing we used Adobe Premiere and Adobe After Effects.

Stage director may also explain video making techniques to the singers, to increase their general skills.

There are interesting and easy programs about film editing such as:

#### **Quik (Android)**

Editing Program useful to create short film extrapolated from a longer one. Better associated with a GoPro. It allows to cut a film, to insert film filters and to save the result.

#### **KineMaster (Android)**

One of the best video editing Apps for Android. It allows complete editing of the film and allows YouTube videos.

#### **Adobe Premiere Pro (Android)**

It allows complete editing of a film and it has a mobile version: Adobe Premiere Rush.

#### **Cyberlink ActionDirector (Android)**

It allows you to cut and join videos, apply artistic effects to them, insert soundtracks, titles, transition effects and much more.

### **InShot (Android, iPhone, iPad)**

It's a good free app to create video and photo montages with artistic effects.

### **iMovie (iPhone, iPad, macOS)**

Apple editor video, allows to edit videos, allows merging, splitting, tests and music adding, creation of trailers.

### **Clips (iPhone, iPad)**

Apple application, light version of iMovie. Creation of short movies.

### **LumaFusion (iPhone, iPad)**

App for video editing professionals.

### **Avidemux (Windows/macOS/Linux)**

### **Adobe Premiere Pro (Windows/macOS)**

### **VEGAS Pro (Windows)**

Advanced App with Smart Split Edit.

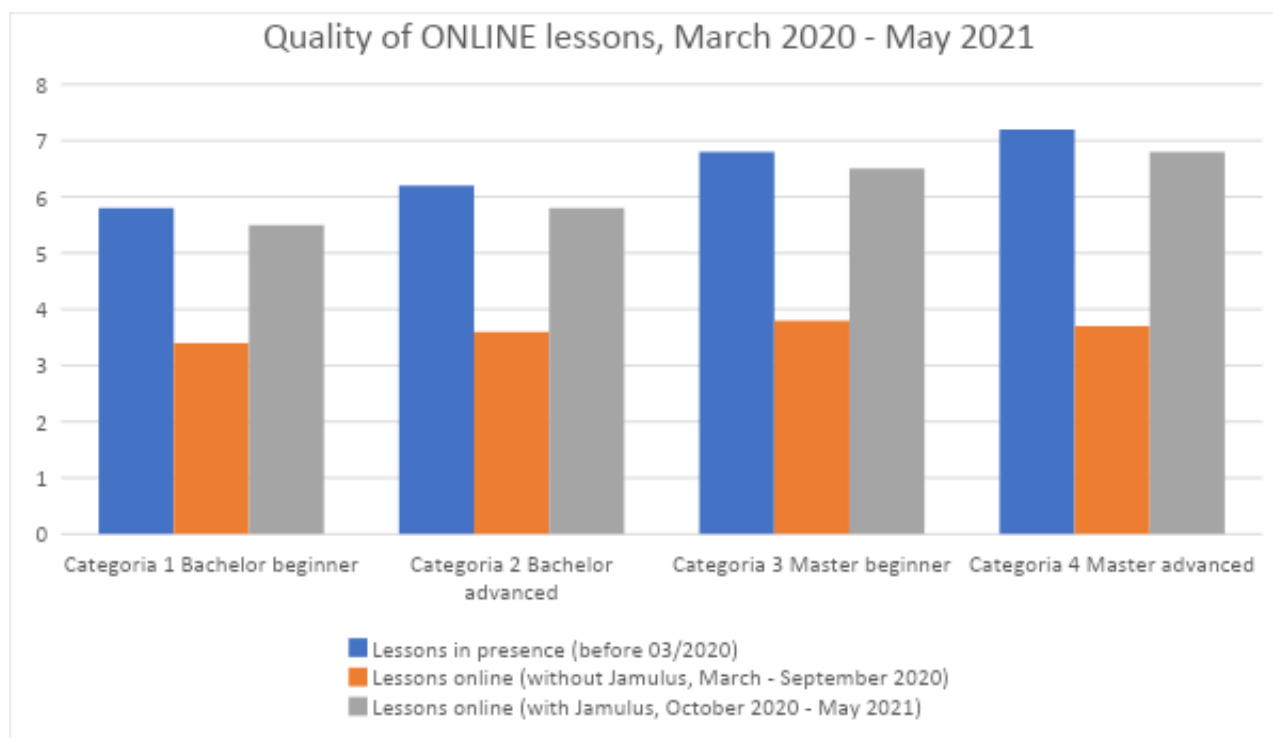
### **Final Cut Pro X (macOS)**

Advanced editing App with video support 360°, HDR and advanced noise removal.

### 3. Experimentation

The experimental part in Networked Music Performance, contextualized in Virtual Stage project, was carried out in two different music environments: the pre-professional higher education environment (License and Master Art Song Interpretation) and professional training (constituted music ensemble training).

The experimental part, from the pedagogical point of view, was carried out by Leonardo De Lisi, professor of Art Song Interpretation at Conservatory Luigi Cherubini of Firenze (Italy) during pandemic lockdown in Italy (March 2020 - May 2021). The amount of the collected data is not sufficient for supporting a full statistical analysis; however the experimentation provides guidelines and trends in the use of Networked Music Performance in the context of Virtual Stage project. This guideline includes a holistic scale of evaluation (for teachers and students) of the quality of the online lessons compared to the presence lessons.



Survey on a group of 24 singers from the Art Song Interpretation “Musica Vocale da Camera” during pandemic lockdown (March 2020-May 2021).

Data: evaluation of academic results (teacher) and appreciation feedback (students) in three precise periods:

1. before lockdown (before March 2020): lessons 100% in presence;
2. during the national lockdown (March to September 2020) without the use of Jamulus: evaluation of the online lessons (100 % of the remaining scheduled lessons for academic year 2019-20);
3. after the national lockdown (from September 2020 on) with the use of Jamulus: evaluation of the online lessons (50-60 % of the scheduled lessons for academic year 2020-21).

Period of Survey: Dec. 27, 2021 – Jan. 22, 2022.

Definition of the survey group:

24 singers of 4 different academic level

1. Bachelor, beginners (1<sup>st</sup>/2<sup>nd</sup> year): 7 students
2. Bachelor, advanced (3<sup>rd</sup> year): 5 students
3. Master, beginners (1<sup>st</sup> year): 6 students
4. Master, advanced (2<sup>nd</sup> year): 6 students

#### Scale of evaluation of academic results (teacher)

- 0 – 1** **Totally negative** (no results, sometimes even sort of a regression to a less advanced level of performing skills: NO pass).
- 1 – 2** **Very poor** (only a minimum progression, lack of organization and many delays in bringing to conclusion the preparation of the assigned work, many mistakes in the evaluation tests, incapable to advance to next level: NO pass).
- 2 – 3** **Poor** (even with some progression the students show evident lack of the required skills in their advancement to next level: NO pass).
- 3 – 4** **Sufficient** (the students meet the basic requirements in their advancement to next level, yet showing some difficulty and some mistakes: PASSED 18/30)
- 4 – 5** **Good** (successful performance of the evaluation tests with good results and only some mistakes: 24/30)
- 5 – 6** **Very good** (very successful performance of the evaluation tests, with almost no mistakes: 27 /30)
- 6 – 7** **Excellent** (almost perfect performance of the evaluation tests, no mistakes and exact execution of all required tasks: 30/30)
- 7 – 8** **Exceeding expectations** (absolutely perfect performance of the evaluation tests, bringing up some very personal and interesting contribution from the students: 30/30 cum laude)



### Scale of evaluation of appreciation feedback (students)

- 0 – 1** **Totally negative** (I don't feel I could learn anything during the lessons, even I have the feeling I got more confused about my performing skills, I am stressed and preoccupied that I will not pass the evaluation tests)
- 1 – 2** **Very poor** (I did only very small progresses during the lessons, and I still have many doubts about my performing skills and how to get better in my singing, I am a bit preoccupied I will not pass the evaluation tests)
- 2 – 3** **Poor** (I did learn what I was expected to, but I don't feel I can really reproduce those same results on my own, I need to repeat this same lesson in order to fully understand what the teacher asks me to do, I am sure that need much more lessons in order to pass the evaluation tests, I feel rather preoccupied)
- 3 – 4** **Sufficient** (I feel I have learned something and that I can reproduce the same results on my own, yet I doubt about some details that I couldn't catch at the lesson, and I don't remember well some other parts: yet I feel quite secure about being able to pass the evaluation tests because I can count on my basic skills)
- 4 – 5** **Good** (I feel secure and positive about what I learned today, I can reproduce the same results on my own and my performing skills are much better than last week: I get some good feeling about being able to pass my tests and I look forward to my next lessons to feel more and more secure in all my next performing events)
- 5 – 6** **Very good** (during the lesson I was able to do something that I wouldn't have been able to do on my own, I feel full of positive energy and willing to progress: I am sure I will pass my tests with a high mark; I am really looking forward to my next lessons and performing events)
- 6 – 7** **Excellent** (I am euphoric about the lesson I have just had; I did everything my teacher asked me to do and I got enthusiastic feedback from him/her: therefore, I feel that my performing skills have advanced so much in the last few months that I can expect the highest marks during the evaluations tests)
- 7 – 8** **Exceeding expectations** (this was the best lesson in my life! My teacher told me that I have reached all the planned goals and advanced even further!)

The students were asked to evaluate the “quality” of their lessons during the three precise periods of this study, mostly concentrating on their feeling of study “fulfillment” or “frustration” about the actual results. The teacher collected his personal notes after the lessons and the marks of the various evaluation tests done before and during the pandemic lockdown and blended them with the students’ survey.

As a general result, it clearly strikes that before the extensive use of Jamulus the online lessons were often unsatisfactory or just sufficient compared to the previous good or very good achievements. The most

important problem being the latency that caused a reduction of performing skills in both the teacher and the student. As soon as Jamulus became a substantial tool in the online teaching methods (together with the enhancement of other digital skills, such as a better Wi-Fi or internet connection, the extensive use of both plugged-in microphone and speakers) we noticed a dramatic change in the quality of the lesson and much better results in the evaluation tests. We can point out that the more advanced students' reaction to the new tools reflects the better situation of the pre-pandemic period, therefore confirming that the quality of the online lessons went back to an almost normal situation, on a trend similar to those in presence. On the other hand, the degradation of both quality and results during the pandemic lockdown in the online lessons (without the enhancement of the digital tools and the discovery of the Jamulus application) clearly shows some almost equal results among all four groups. When before the pandemic the general level would settle between 5-6 (good) and 7-8 (exceeding expectations), those 6 months under strict national lockdown (100% lessons online) caused the general results to a dramatic drop in the 3-4 (sufficient) level: lessons and evaluation tests showed to be "just" sufficient, somehow canceling the possibility of excellence even in the most advanced students. As soon as Jamulus came in, the general use and when we were allowed to blend online lessons with others in presence (40-50%), the quality of the academic work jumped back to a pre-pandemic situation.

### 3.1 The "Orfeo" case study: distance/blended rehearsals and technological performance

#### Multitrack Recording

This recording methodology is inspired by over half a century of experience in the pop music industry. Unfortunately, in Classical Music there is often mistrust of innovation and this precludes the possibility of experimenting with innovative techniques and methodologies for the sector even if already experimented in contiguous repertoires. For this reason, Orfeo's experience was a milestone in the proposal of the Virtual Stage method also in the specific aspect of recording.

Multitrack recording allows you to simultaneously use sample sounds of historical instruments performed on midi keyboards or EWI and an instrument / voice with microphone. This allows you to have eg. 3/4 separate tracks which can however be played and recorded simultaneously.

It is necessary to have the click for the mensural passages before the beginning of the piece and also during the entire performance.

It is advisable to record harmonic and grave instruments first and then melodic and acute instruments.

This also allows you to select the instrumental arrangement in some cases in the post-production phase.

If intonation problems occur, it is possible to use tools such as Melodine, while for the synchronous it is possible to align the different voices / instruments during the editing phase.

Multitrack recording is crucial for the realization of tutorials and partial playbacks with the flexibility of being able to add / exclude the desired voices from time to time.

### **Partial Playbacks**

This mode is inspired by pop music concerts and involves the interaction between pre-recorded sections and live musicians. For *L'Orfeo* partial playbacks were used for choir, cornets, trombones, percussion. The result is extremely immersive from the sound point of view and allows the public, especially in open air venues, to perceive and enjoy the impact of the choral and orchestral masses.

For the interaction of live musicians, 2 modes were tested:

1. Director, Singers and Instrumentalists all with headphones and clicks only at the beginning
2. Only the conductor with headphones and clicks throughout the song.

### ***L'Orfeo*, a Virtual Stage milestone**

In the previous section we have discussed a specific experience, the staging of *L'Orfeo* by Claudio Monteverdi, in order to illustrate the use of a technological approach in the training process finalized to the recording of an opera. In this context, the recording must be understood as a multimedia product (both audio and video) which serves multiple purposes: the release of a cd, the publication on Youtube, and the preparation for the performance itself. To achieve this goal, two main tools were adopted, i.e. tutorials and multi-track recording.

This part is strictly connected to the above, as it refers to the same case study, but this time the focus is on the rehearsals and the performance of the opera, which took place in Florence in June 2021. Our report aims to highlight the differences between a traditional staging of this great masterpiece and a “virtual stage” version, which required a considerable effort from “classical” musicians who are certainly not accustomed to technological devices in their everyday practice. Besides singers and instrumentalists, the show included also a dance company, an artistic video projected on a big screen and functioning as backdrop, and an actor playing Dante Alighieri: the presence of the latter was motivated by the affinity of the great poet with

Orpheus, as many explicit and implicit references to this mythological figure can be traced in the *Divine Comedy*.

Despite its experimental character, the performance was highly satisfactory: however, some flaws emerged, and it is important to consider alternative solutions in order to make future live experiences increasingly more enjoyable, both for the performers and the audience. The difficulties encountered during the concert will be briefly discussed at the end of this chapter.

*L'Orfeo* is universally renowned as a milestone in the history of musical drama, as it combines the traditional elements of the Renaissance era with the newly established vocal style, the so-called *recitar cantando*. Unlike the two other surviving titles by Monteverdi, *Il ritorno di Ulisse in patria* and *L'incoronazione di Poppea*, which were composed much later, *L'Orfeo* envisages an extraordinary variety of instruments of all sorts, whose distinctive sound is masterfully employed by the author to portray the different worlds represented in the story. For the purposes of this analysis, it is worth reminding the instrumentation and the characters of the opera; in fact, the first concept underpinning our arrangement is **the use of a smaller orchestra for the live performance, as many of the instruments had been pre-recorded and their presence is only virtual**. Below the list according to Monteverdi's 1609 score:

Table 1

ROLES	INSTRUMENTS
La Musica (Prologo)	2 harpsichords
Orfeo	2 double-basses
Euridice	2 five-part string ensembles ( <i>viole da braccio</i> ), each comprising two violins, two violas and cello
Coro di Ninfe e Pastori	
Speranza	1 double harp
Caronte	2 chitarroni
Coro di Spiriti infernali	2 organs
Proserpina	1 regal
Plutone	3 bass viola da gamba
Apollo	4 trombones (sackbuts)
	2 cornettos

Coro di Pastori per la moresca	3 trumpets 1 recorder
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As already stated, the orchestra used for the concert was far smaller than the one displayed in the table above. So, how were the missing instruments replaced? The answer is: through the use of **sample sounds**. During the recording sessions, each musician involved in the project was asked to play the whole range of his/her instruments, note by note. Also this process is consistent with the philosophy of the “virtual stage” approach, because the sounds were not taken from random libraries on the web, but from real musicians who virtually interacted with their colleagues playing live. The sounds obtained - once proven to be reliable and acceptable in terms of quality - were recorded, transferred to a specific software and adjusted according to the meantone tuning at 440 Hz. The samples could now be played by using following equipment:

- a MIDI instrument. Besides the keyboard, another device was chosen, the EWI (Electronic Wind Instrument), a device capable of reproducing the sound of other instruments through a simple USB interface;
- a laptop with multiple USB ports;
- a software enabling performers to run sampled instruments. For this purpose, all the musicians who were supposed to play in presence were required to download KONTAKT, the most widely used host platform developed by NATIVE INSTRUMENTS;
- an audio interface connected both to the computer and to the keyboard;
- a pair of earphones connected to the central mixer and the speakers.

The table shows the distribution of the instruments in the live performance. As can be noticed, only ten musicians were physically present at the concert (the recorderist played also one of the two EWIs), while the other ten could be virtually heard through the MIDI instruments. For the remaining strings, which are excluded from this list, the partial playback was used.

Table 2

ACOUSTIC INSTRUMENTS	MIDI INSTRUMENTS	SAMPLED INSTRUMENTS PLAYED BY MIDI INSTRUMENTS
recorder	2 EWI	trumpet

<p>2 violins 2 chitarroni</p>	<p>4 keyboards</p>	<p>recorder cornetto sackbut cello double bass harpichord organ harp regal</p>
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After this necessary clarification about the composition of the orchestra, the use of sampled instruments and the interaction between physical and virtual players, we are now going to provide a thorough account of the rehearsals and the performance.

### Rehearsals

The rehearsals, which lasted one week, were held in a large indoor space, and involved all the artists in presence: instrumentalists, singers, dancers and one actor. Besides them, a technological project like this required a staff of skilled professional technicians - mostly sound and video engineers - in charge of various tasks. More precisely, they had to: 1) check that all the softwares were correctly installed on each laptop 2) make sure that all the MIDI instruments were properly connected; 3) regulate the volume of all microphones and individual earphones; 4) start and stop the playbacks; 5) run the video on the screen.

In this kind of performance, the hardest challenge is to play and sing along with the base. To achieve this goal, the most obvious expedient is the introduction of a click sound to mark the beginning of the piece and to ensure synchronicity. The musicians had already become familiar with this method during the individual recording sessions, since each of them was supposed to play his own part after someone else. The fundamental difference is that, while the recording makes it possible to stop and repeat many times, until the result is perfectly acceptable, the rehearsals force the performers to link one piece to the following, without any interruption. For this reason, a member of the technical staff capable of reading the musical score is assigned a very delicate task, i.e. to indicate to the sound engineers the exact moment where the

click should start: not too early, otherwise the echo of the final note drowns out the click, nor too late, which would result in an unnecessary break between two sections. Any minimum inaccuracy may be dangerous and alter the natural flowing of music.

In addition to synchronicity, the second main difficulty for musicians who have never experienced playing with earphones and microphones is the regulation of volumes. On one side, it is essential to hear the click and the playback throughout the whole section; on the other hand, the base must not be too loud, as this might negatively affect the production of his own sound. This might be really frustrating for singers, for whom the perception of their voice is the first and foremost condition to the act of singing and consequently to a good interpretation.

The third difficulty related to such an innovative model regards the MIDI instruments and the use of KONTAKT. Before and during each session, although the players are constantly supported by the technical staff, they are responsible for a set of crucial operations:

- check the audio and MIDI settings of KONTAKT. The selected MIDI channel must be the same for all the instruments loaded. In the audio options, the proper device (audio interface or built-in microphone) must be selected;
- the platform enables the simultaneous upload of two or more libraries of sample sounds: when switching from one instrument to another, it is necessary to mute the instruments that are not being played;
- apart from the general volume regulated by the sound engineer through the central mixer, each musician should set his/her own volume on KONTAKT.

In light of this account, it should be clear how a musical production based on technology and a virtual - or semi-virtual - approach poses new challenges to all the artists involved. However, in respect to singers, the MIDI instruments are charged with various additional tasks which require not only concentration, but also readiness and flexibility.

## Performance

In a virtual stage performance, a limited number of musicians covers all the instruments in the score. As for the present case study, the structure of the orchestra is shown in table 2.

While the rehearsals took place indoors, the performance was held in a beautiful location outdoors. Obviously, the different acoustics must be taken into consideration by the sound engineers when placing the microphones and regulating the volumes.

Unlike the instruments, **all the singers playing individual roles were present at the performance**, but only two of them appeared on the stage, wearing a headband microphone: La Musica in the prologue and the

protagonist, Orfeo. The others were standing all around the circular stage, dressed in black and unseen to the audience, except when they had to sing. The choruses were sung by all singers with the support of a pre-recorded base.

The orchestra was also positioned around the stage, and each musician was provided with all the necessary equipment: microphone, headphones (for everyone); laptop and audio interface (only for MIDI instruments). In the backstage, there was the workstation from which the technical staff could control all the operations described in the previous paragraph.

Although it might seem superfluous, something must be noticed regarding the playbacks. First, during the playback section the live instruments are not inactive - it would be terrible to see an orchestra or ensemble standing still while recorded music is being played! On the contrary, the live music has to overlap with the base in order to create an extremely powerful effect of “tutti” as well as to preserve one of the main characteristics of early music, i.e. spontaneity of expression and improvisation. Consequently, this method can be applied only to some parts of the opera, where the rhythmic stability allows for a reasonably safe interaction without going the risk of asynchrony. Which are these sections? With reference to *Orfeo*, these are: the initial *toccata*, all the choruses and sinfonias and the final *moresca*. For all the other parts, namely recitatives, duets and trios, the playback is not applicable, as it would be totally unnatural for singers to be tied to an unchangeable version, while they need an accompaniment that respects breathing and rhythmic freedom.

### 3.2 Professional training: case study of ensemble Lira Transalpina

The first use of Networked Music Performance techniques with Jamulus for the Virtual Stage project was carried out by the ensemble Lira Transalpina during early stage of project designing process<sup>1</sup>. The experimentation was carried out by all the members of the ensemble<sup>2</sup>.

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<sup>1</sup> concept design by Carla Zanin and project management by Federico Bardazzi.

<sup>2</sup> Andrea Bareggi, Elodie Colombier, Patrick Nedel, Angelo Chardonnet.



### 3.3 Distant learning setup: recording a NMP session with video

- 1) open Kontakt;
- 2) load the Blanchet;
- 3) configure ASIO output on speaker;
- 4) open Jamulus;
- 5) open Reaper with ReaRoute template;
- 6) connect to a server.

### 3.4 Minimal tools and materials required

Usually, the size and the mass of the music instrument the vocal coach/continuitist uses (piano, harpsichord, organ) constrains the musician to work on a specific location - and the instrument is difficult to displace on the stage, with the exception of a small digital keyboard. For this reason, microphones should be placed at specific positions.

#### Recording an acoustic piano/harpsichord and sending audio signals through the internet:

- 1) A fast and reliable internet connection. Some reference value:
  - Fast internet connection: Ping (ms): 11, Download: 260.17 Mbps, Upload: 342.23 Mbps
  - Normal internet connection: Ping (ms): 15, Download: 268.50 Mbps, Upload: 90.24 Mbps
  - Slow connection: Ping (ms): 25, Download: 41.54 Mbps, Upload: 19.33 Mbps

Fast and Normal connections can be used for PPB and NMP both. NMP could be difficult for Slow connections, so PPB is advised. Internet speed can be measured directly online. Find here some links for making your own measurements: [Link 1](#), [Link 2](#).

- 2) A microphone (external USB or internal).

Internal microphones of computers and smartphones can be used only by accepting a poor sound quality. Quality can be improved by using a mini-jack microphone or USB microphone (best choice).

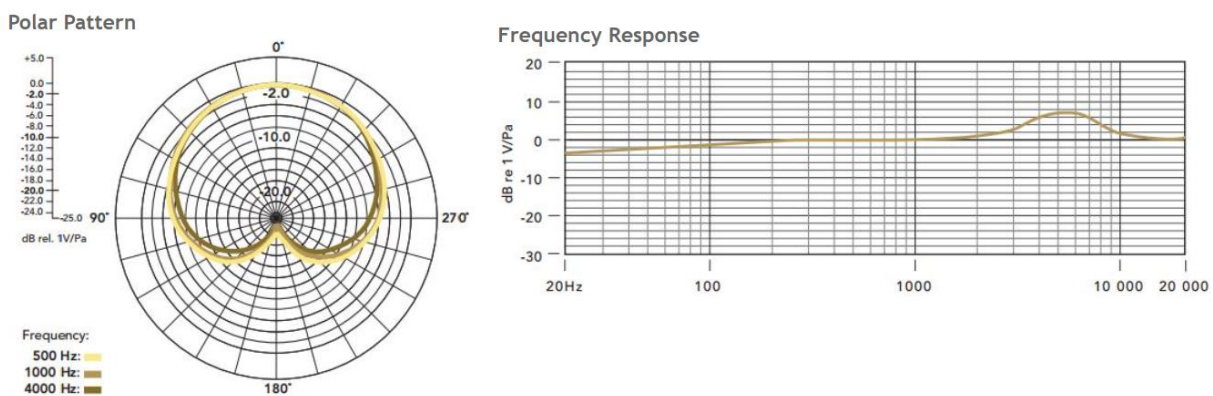


*A mini-jack microphone kit and a USB microphone*

Basic parameters in the choice of microphone are:

- gain frequency response: it represents the gain (measured in dB) as a function of the frequency (measured in Hz);
- polar pattern: a graphical representation of recording direction.

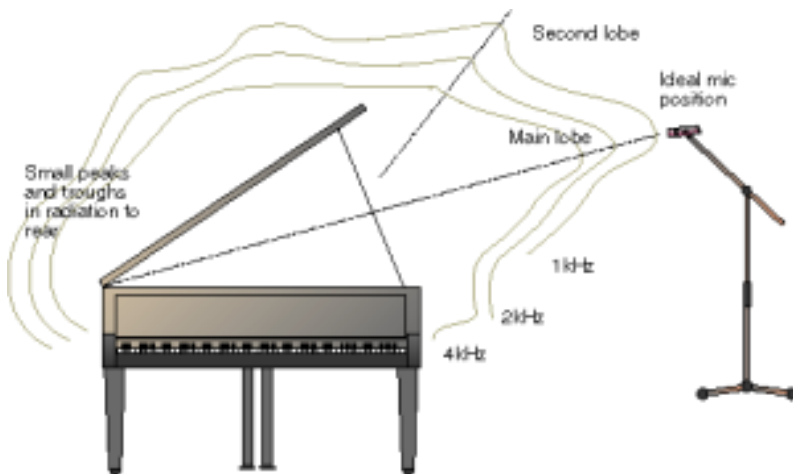
There are several guides on the internet for the optimal choice of a microphone. Find [here](#) the link to one of them. USB microphones can be also used as USB audio board.



*An example of the polar pattern and the frequency response of an USB microphone*



The position of the microphone is particularly important when recording a piano or a harpsichord. It is possible to find some useful advice on the internet.



Using two or more microphones to create a stereo image provides depth and localization of an instrument in the registration. There are many different methods of achieving stereo.

Using two or more microphones to create a stereo image provides depth and localization of an instrument.

## **COINCIDENT MICROPHONES**

For this type of miking, the microphones are placed in the same spot. This means that two almost identical signals arrive at the two microphones, and the difference between the two will be determined only by the amplitude and not by the phase.

For this reason, a microphone of this provides a “monocompatible” signal frequently used in the radio and television sector, but also in the recording of instruments with reduced spatiality.

### **X/Y technique**

Using two identical microphones with cardioid polar pattern, with the capsules positioned just in contact one with the other or separated from each other by less than 30 cm.

The microphones are oriented towards each other at an angle of 90 ° to 135 °, depending on the size of the sound source and the desired stereo image.

The pair is positioned with the center point of the two capsules pointed at the source. The two microphones are panned to the right and left in the stereo, the sound reaches the two capsules at the same time, reducing (in the case of the quasi-coincident pair) or eliminating completely (in the case of the coincident pair) the phase shift problems possible with the A / B technique.

### **M/S technique**

The M / S stereo recording technique (Mid-Side - center-lateral) employs a microphone capsule with cardioid polar characteristic and a bidirectional capsule, sometimes housed in the same unit, configured in a coincident way.

The cardioid capsule (mid - center) is pointed directly at the sound source.

This mainly picks up the on-axis sound, while the bidirectional capsule (side - side) picks up the off-axis sounds of the cardioid capsule on the left and right.

The two signals are combined through the use of an M / S matrix, which allows you to adjust the spatiality of the stereo image. By adjusting the level of the "mid" signal and laterals signal, it is possible to create a wider and more stereo image, without moving the microphones.

This technique is perfectly compatible with playback in monophony and, consequently, much is used in television, radio and film applications.

## **NEAR MICROPHONES**

These techniques involve the use of two microphones at a distance of 15 - 20 cm from each other. This is approximately the average distance between human ears.

In case of very large sources or different personal needs, both the distances and the reciprocal inclinations between the microphones can be changed.

With this configuration, in addition to the differences in amplitude, it is also possible to record the phase differences between the two signals. On the one hand, this improves the rendering of the stereo effect but significantly affects the mono-compatibility of this technique.

### **ORTF technique**

(Organization Radio Television Française)

This French technique involves placing the two condenser microphones with a cardioid polar pattern at a distance of 17 cm and at an angle of 110 degrees.

### **NOS technique**

(Dutch technique)

It involves the use of two cardioid microphones placed 30 cm apart at an angle of 90 degrees.

## **FAR MICROPHONES**

The microphones are also placed at a great distance from each other. The distance between the microphones depends on the size of the sound source. The rule is to maintain the 3: 1 ratio between the distance between the microphones and the distance of the microphones from the sound source.

These techniques prevent mono compatibility therefore they are used only in certain contexts.

### **The A / B Technique**

Use two microphones with omnidirectional cardioid polar features, separate by a distance of 1 to 3 meters, and pan all the way left and right in the mix. This technique is often used for recording the stereo image of a group or instrument. The stereophonic separation in this case is very wide. The distance between the two microphones depends on the physical dimensions of the sound source.

Due to the relatively large distance between the two microphones and the resulting difference in the arrival time of the sound at the microphones, cancellations and additions can result at certain frequencies.

## 4. Tech

### 4.1 Best practices for simple and effective recording and sound sharing by internet connection

The methods of recording and sharing audio via an Internet connection require the introductory technical clarification of certain key concepts relating to the necessary tools.

A sure and necessary goal is to understand how a sound source can be technically captured, and the result recorded or otherwise shared.

To do this, we need to introduce the concept of a transducer.

A transducer is a device that converts one physical quantity into another. In our case, the transducer is the microphone. From this device, the signal travels in a cable to a device called preamplifier.

In fact, a microphone converts a sound pressure applied on a capsule into a voltage.

There are several categories of microphones, classified according to the method of operation. The main categories are dynamic microphones, condenser microphones and ribbon microphones.

Each of these categories has specific characteristics.

Dynamic microphones involve the movement of a moving coil in a permanent magnet, due to the effect of sound pressure. The movement of the coil causes a voltage change. Such microphones, often used in live applications, are very durable, but tend to have limited performance at high frequencies, and not necessarily excellent sensitivity.

Condenser microphones, on the other hand, generally much more sensitive and with a more natural frequency response in the highs, rely directly on the operation of the condenser. The sound pressure is converted into voltage due to the movement of one of the plates of the capacitor itself. Such microphones require a power supply in order to function. This needed power to charge the condenser is frequently supplied in the form of Phantom Power - that is, sending 48V through the use of the same XLR cable on which the audio is carried. The tube condenser microphones have their own power supply.

Ribbon microphones tend to be analogous to dynamic microphones. In fact, there is a very thin ribbon suspended in a permanent magnet. Such microphones have historically tended to require a high preamp and are extremely fragile. They do not require Phantom Power (unless otherwise specified by the

manufacturer). Indeed, sending 48V to the microphone itself is to be avoided, unless otherwise indicated, because it would compromise the microphone itself.

Microphones are also classified in relation to their directionality.

There are directional, bidirectional and omnidirectional microphones.

Directional microphones (cardioid, sub-cardioid, hypercardioid pattern, etc.) tend to mainly capture the signal directly and frontally introduced into the capsule, and reject the signal, in different ways and quantities, for positions other than the axis of the capsule itself.

Directional microphones tend to manifest an effect called proximity: approaching the sound source to the capsule, there will be an unnatural increase in the yield of low frequencies. This effect can be compensated for in equalization if necessary, but it can also be used to your advantage if the low frequencies need to be emphasized.

The bidirectional microphones, on the other hand, capture signals from the front and rear. The omnidirectional, 360 °.

The signal that comes out of the microphone must therefore reach a device called a preamplifier, which does nothing but increase the amplitude of the signal it receives, that is, its voltage. This is done by acting on a control called gain.

The preamplifier is part of another useful device for our purposes: the audio interface.

The signal which, then, captured with the microphone, is preamplified, is then subsequently processed by the audio interface itself. This processing is called conversion.

The signal is converted from continuous to discrete by means of an analog-to-digital converter.

This signal is measured a certain number of times per second (sampling frequency). The measurement is then approximated, in a fictitious grid, in the dynamic range, by means of the bit depth. In practice, the bit depth is needed to represent the loudness at a given moment. The greater the bit depth, the greater the dynamic range represented. A bit depth of 16 guarantees 65535 quantization levels (one bit is used for the sign), while a bit depth of 24 allows for more than 16 million quantization levels.

As for the sampling frequency, that is the number of signal measurements in a second, it is always the theoretical double of the maximum sampling frequency. The minimum value commonly found in audio devices today is 44100 Hz.

Once the signal has been converted, it can be processed in software.

In our case, the software used will be Digital Audio Workstations or Jamulus.

Digital audio workstations are software that have been developed since the mid 90's for the integrated management of MIDI and Audio data.

This management takes place in projects. Each project is made up of units called tracks.

A track is a container of audio or MIDI events. Within a track, we identify what is generally called a region, event or item.

A track can contain one or more regions. In some software, in addition to the properties of a track, you can also have specific properties for the individual items it contains.

There are generally three different types of tracks: audio tracks, MIDI tracks, and virtual instrument tracks.

Audio tracks are containers of audio regions that point to a file stored in mass memory; MIDI tracks are containers for MIDI events (messages); virtual instrument tracks are tracks with regions that contain MIDI events, but which output an audio signal through software that interprets these events.

In order for a track to be enabled for recording, it must be armed.

The possibility of obtaining a prompt response in listening to the input signal, while playing and recording, depends on a parameter available in the configuration of the audio interface, within the software, called buffer size.

The buffer size is a form of buffer memory, which the system uses to ensure a continuous stream, free of interruptions, clicks or pops, of data from the sound source to the software.

The buffer size, generally expressed in samples, necessarily determines a latency - that is, a form of delay.

To record, or in any case to send the signal to the software more promptly, you will have to try to keep the buffer size as small as possible, that the system can support.

In fact, how small the buffer is, depends on the overall performance of the computer.

However, the latency time is also a function of the sampling frequency. With the same buffer size, a higher sampling rate will result in a lower total latency.

As far as audio events are concerned, they are represented in a timeline by means of the use of pointers. It is in fact possible to resize a region to delimit the playback of the audio content available in digital format, in a non-destructive way.

If you are using files already available on the mass memory, just drag them into the project timeline.

Usually, unless specified by the user, deleting a region does not delete the file it points to.

In DAWs, time is represented horizontally, and event containers (tracks), vertically.



It is therefore also possible to move regions in space horizontally, to obtain a reproduction differential over time.

The most frequently used tools to manipulate regions are separation (scissors) and resizing.

Audio regions, in the case of joining together, require an operation called cross-fade. This causes the signal to fade out of the previous temporal region and into the next temporal region, to avoid clicks or pops in playback.

Furthermore, the signal can be further manipulated at the output by means of the mixer.

The mixer is a device, in our virtual case, which allows you to adjust the volume of each audio track or virtual instrument, the positioning in the stereo field (panning), manage the sum of the signals (master channel). The mixer also allows you to manage devices being inserted (for example: equalizers, compressors), or to create sends to auxiliary channels (often used for managing effects such as reverb or delay).

Among the devices, which from now on we will call plugins, which can be inserted in the mixer, there is also ListenTo - a software that, by means of a streaming subscription service, allows you to capture the sum of the signals from the master channel and send it through servers to remote clients, set up with a receiver, which can also be a web browser or a remote DAW channel, always in the form of a plugin.

In parallel, a different type of software that can be used for our purposes is Jamulus - in the case also in combination with DAWs such as Reaper.

Jamulus is an integrated solution for creating servers and clients to provide musicians with the ability to collaborate and play remotely.

You need to use a microphone, an audio interface, a pair of headphones, and preferably a good stable cable connection.

In the configuration parameters, it is possible to specify not only from which input the signal to be streamed to the server is received, but also the buffer size. As we have already seen, you will have to try to keep the buffer size as low as possible. It is necessary to make some attempts, in order to determine which are practically for the session the smallest tolerated buffer size values, for the management of the audio and for a correct streaming.

#### **4.1.1 Equipment: Microphone, Sound board, Digital Audio Workstation (DAW)**

We recommend using both a soundcard and a microphone, due to more flexibility and expandability during the learning process both of students and institution/trainer.

Also, the soundcard is mandatory for everyone who use a MIDI Keyboard with midi output (newer keyboard uses Usb for MIDI) or any other Midi instrument.

We can identify three levels:

- Institutional level
- Trainer level
- Student level

### **Audio Interfaces**

Institutional Level:

- Arturia Audiofuse Studio
- Arturia Audiofuse
- Focusrite Scarlett 18i8 3rd gen

Trainer Level:

- Arturia Audiofuse
- Focusrite Scarlett 18i8 3rd gen
- Focusrite Scarlett 8i6 3rd gen

Student Level (with a PC):

- Focusrite Scarlett 4i4
- Zoom U24

Student Level (without a PC, requires a Tablet or a Cellphone, for IOs and Android):

- IK multimedia iRig Pro Duo I/O
- TC Helicon Go Twin
- IK multimedia iRig Pro
- TC Helicon Go Solo

### **Microphones**

Istitutional Level:

- Aston Microphones Spirit (Pair)
- Lewitt LCT 440 Pure (Pair)

#### Trainer Level:

- Aston Microphones Origin (single)
- Lewitt LCT 440 Pure (single)
- Audio Technica At2035 (single)

#### Student Level:

- Audio Technica At2035
- Lewitt LCT240 PRO
- Audio Technica At2020

#### Setup without Soundcard

##### Trainer level:

- Audio Tehcnica At 2020 usb plus
- Rode NT-USB

##### Student Level:

- Rode NT-USB mini
- Samson Q2u Podcasting

##### Software:

##### Pc user (MacOs, Windows, Linux):

- Reaper
- Cubase Elements (or higher version)
- Kontakt (full version, for Virtual Instrument players, not available for Linux)

##### Tablet/Cellphone user (android, IOs, Chrome OS):

- Cubasis 3

Brands and relative models showed in this article are examples of many possibilities that the market offers at the time the article has been written, and they are all intended to be just samples. The product have been chosen with the purpose to maintain the highest possible price to performance ratio.

All the choices have been made thinking to the relative budget of the three identified levels; the institutional level (conservatories, schools, music schools) has the highest budget of the three, the teacher level has the

medium budget, and the students the lowest.

With every level and setup, it's possible to work flawlessly, however for streaming lessons and playback, we strictly recommend to follow the institutional or teacher level.

## 4.2 The two methods used in Virtual Stage

The two methods used in Virtual Stage refer to the use of the aforementioned ListenTo and Jamulus.

ListenTo is a subscription service, where the software is provided free of charge. Basically, subscriber users have the ability, through the use of proprietary servers, to stream high-quality audio signals remotely. The receiver gets a link to connect to, and can consequently therefore receive this signal.

In Jamulus, on the other hand, anyone has the free possibility to set up servers, even private ones, or to use servers set up by others.

The Quality of Service is not necessarily guaranteed in the same way compared to ListenTo: it depends on the respect of the best conditions established by the software manufacturer by the users.

These best conditions are:

1. Connection quality: avoid using WI-FI (latency induction and potential instability) and prefer cable connections (for example, ethernet)
2. Appropriate network configuration: control of access to the network by the computer device used and control of the local network (for example: router / modem configuration)

On paper, therefore, Jamulus is a more "democratic" tool, since it theoretically allows anyone to set up streaming audio sharing services but has the disadvantage of requiring users to comply with specific technical requirements.

Audiomovers Listento is the solution chosen to stream, listen to and record high resolution multichannel remote audio in real time, with multiple collaborators, anywhere in the world. The solution includes a set of plugins, Listento and Listento Receiver, as well as mobile apps. It is also possible to receive the audio stream through a web browser. User-selectable latencies permit to match internet connections or sync to video chat. The Hi-Resolution Audio stream is with AUDIO AAC or PCM options. It is also possible to stream mono, stereo, quad, 5.1 or 7.1 surround audio. Compatibility covers all major DAWs.

Jamulus, on the other hand, is an open source (GPL) networked music performance software that enables live rehearsing, jamming and performing with musicians located anywhere on the internet. One key problem is of course, latency.

To reduce latency as much as possible, Jamulus makes use of compressed audio and the UDP protocol to transmit audio data.

The total latency is mainly composed of:

- Network latency – due to delays within the network
- Conversion latency – AD/DA conversion

As explained, Jamulus is client-server based. Each client transmits its own audio in a compressed format to a server. The server mixes the decompressed audio stream for each user separately and re-transmits the individual compressed mix to each client. Each client is provided with a mixing console to control the balance of the various received signals. Servers can be either public or private.

#### **4.2.1 Networked Music Performance made easy: a cost-effective method for synchronous and real time performance for music ensembles.**

The evolution of technology and the consequent increasing speed of digital communication networks allows to improve the communication experiences with the dramatic reduction of the virtual distances.

The Virtual Stage project aims to develop and improve tools for distance learning of music and to collect such tools in integrated remote environments for music interaction and education. Within the project, we have chosen two techniques for distance learning: Partial Playback and Networked Music Performance (NMP); this paper is mostly concerned with the latter technique.

Networked Music Performance is an area of ongoing research. The relationship between technology and contemporary popular or electronic music is a well-established field based on computer based communication. As networking is evolving from a communication medium to a shared space virtually inhabited and animated by bodily presences. Chamber music is a social musical practice characterised by peculiar spatial and temporal interactions. In NMP, these relationships are altered by the interposition of the network. NMP computer systems are categorized according to their temporal (synchronous/asynchronous) and spatial (co-located/remote) dimensions. NMP focuses on remote music performance systems supporting real-time synchronous musical interactions among geographically-displaced musicians of the above categories and aims at reproducing realistic environmental conditions for a wide range of applications from tele-auditions, remote music teaching and rehearsals, to distributed jam sessions and concerts. However, several aspects of musical interactions must be taken into account. Musicians practicing in the same room rely on several modalities in addition to the sounds generated by their instruments, including sound reverberation within the physical environment and visual feedback from movements and gestures of other players.

Here we focus on technological issues related to near-real-time performance between musicians in remote locations, with particular interest in professional training in the opera environment. As the Covid-19 pandemic has threatened the continuity of training activities in music education, some solutions are emerging as viable possibilities in distance and blended learning in music education. Therefore, the NMP approach is of particular interest in the context of Virtual Stage. Using partial playback or NMP techniques, virtual exchanges in music, vocal and instrumental practice can be realised. Rottondi et al. presented a comprehensive review of NMP technologies, reproduced in the table below:

Authors	Name	Architecture	Network range	Network protocols	Data type	#AudioChannels	Multi-stream synchro	Codec
Saputra et al.	BeatME	Client-Server	LAN, WLAN	UDP or OSC	MIDI	16 (input), 1 (output)	none	uncompressed
Kurtisi, Gu et al.	-	Client-Server	LAN	RTP, UDP (stream) TCP (session data)	audio	n.a.	NTP	ADPCM, FLAC (real-time) or MP3, MPEG4 (on demand)
Renwick et al.	Sourcencode	Client-Server	LAN	UDP	MIDI	n.a.	none	uncompressed
Stais et al.	-	Client-Server or P2P	WAN	n.a.	audio	2	NTP	uncompressed
Kapur et al.	Gigapopr	Client-Server	WAN	UDP	audio video MIDI	n.a.	n.a.	uncompressed
Wozniowski et al.	Audioscape	Client-Server	WLAN	n.a.	audio	1 (input), 2 (output)	GPS	uncompressed
Sawchuk, Zimmernann, Chew et al.	-	Client-Server	WAN	RTP/RTSP, UDP	audio video MIDI	16	GPS, CDMA	MPEGI-4
Akoumianakis et	Musinet	Client-Server or P2P	WAN	SIP (signaling),	audio video	any	none	OPUS (audio), H.264 (video)

al.				RTP (stream), HTTP (text)				
Carot et al.	Soundjack	P2P	WAN	UDP	audio video	8	external master clock	ULD, OPUS (audio), uncompressed or JPEG video
Drioli et al.	LOLA	P2P	WAN	TCP (control) UDP (stream)	audio video	8	n.a.	uncompressed audio and video
Lazzaro et al.	-	Client-Server (control) P2P (media)	WAN, WLAN	RTP/RTCP, UDP (stream), SIP (signaling)	MIDI	16	RTP/RTCP synchronizatio n tool	MPEG4
El-Shimy et al.	-	P2P	LAN		audio video	n.a.	n.a.	
Fischer et al.	Jamulus	Client-Server	WAN	UDP	audio	2	none	OPUS
Caceres et al.	Jacktrip	Client-Server or P2P	WAN	UDP	audio	any	software- based audio resampling	uncompressed
Akoumianakis et al.	Diamouses	Client-Server or P2P	WAN	RTP, TCP/UDP	audio video MIDI	any	internal metronome stream	uncompressed audio, MJPEG video
Gabrielli et al.	WeMust	P2P	LAN, WLAN	TCP or UDP	audio MIDI	12	software-based audio resampling	uncompressed or CELT
Meier et al.	Jamberry	P2P	WAN	UDP	audio	2	external master clock	OPUS
Chafe et al.	StreamBD	P2P	WLAN	UDP, TCP	audio	any	none	uncompressed

#### 4.2.2 Software used in previous NMP projects

Some of the softwares in the table was used for developing the InterMUSIC project. We cite some of them: JackTrip was developed by the SoundWIRE research group at CCRMA in order to support bi-directional music performances. It is based on uncompressed audio transmission through high-speed links such as Internet2. In the current version, it does not support video transmission.

The LOLA project was developed by the Conservatory of Music G. Tartini in Trieste in collaboration with the Italian national computer network for universities and research (GARR). LOLA is based on low-latency audio/video acquisition hardware and on the optimization of all the steps needed to transmit audio/video contents through a dedicated network connection.

On the other side, UltraGrid is an open-source software that allows audio/video low latency transmission. While its performance is still far from those achieved by LOLA, it is more flexible for generic hardware and networks and it allows contributors to implement new functionalities.

#### 4.2.3 The framework of Networked Music Performance

A music performance occurs when two or more subjects musically interact together through a medium. Subjects can be musicians during a rehearsal, as well as trainers and students. In order to consider a large number of probable scenarios, a performance can occur with all the subjects in the same room (local performance), with all the subjects geographically distant (networked performance) or with part of the subjects in the same place and part of the subjects geographically distant (mixed performance). Subjects interact by means of a medium. In the case of local performances, the medium is a physical medium, such as simple air propagation. In the case of networked performances, the medium is a network and a communication interface, such as an Internet connection and the NMP software/hardware equipment used in order to connect the two subjects. In the case of mixed performance both physical medium and networked medium are involved.

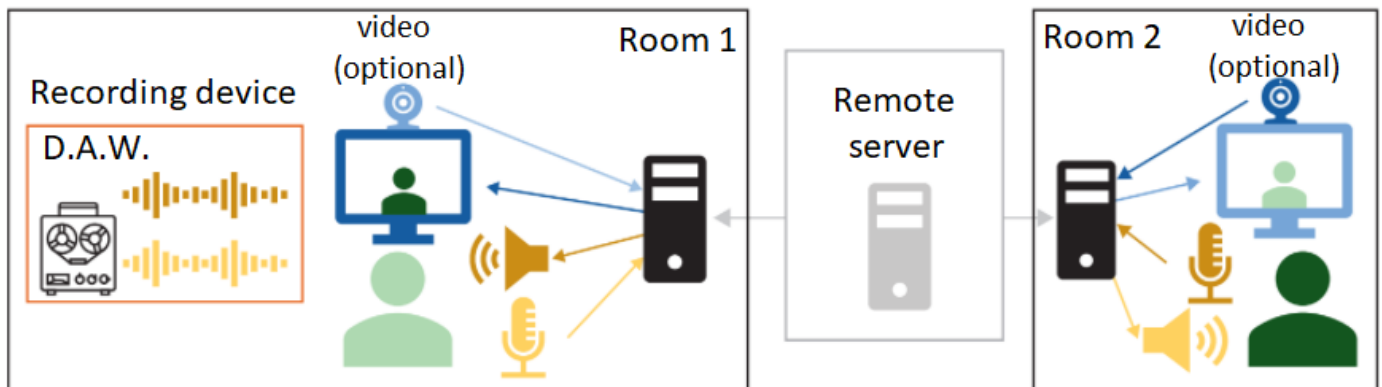
#### 4.2.4 Materials and Methods

The NMP method used in Virtual Stage is based on the Jamulus free and open-source software programmed by Volker Fischer et al. in C++. This NMP software enables live rehearsing, jamming and performing with musicians located anywhere on the internet. Jamulus is Open-Source software (GPL, GNU General Public License) hosted at SourceForge and runs under Linux, Windows and MacOS. It is based on the Qt framework



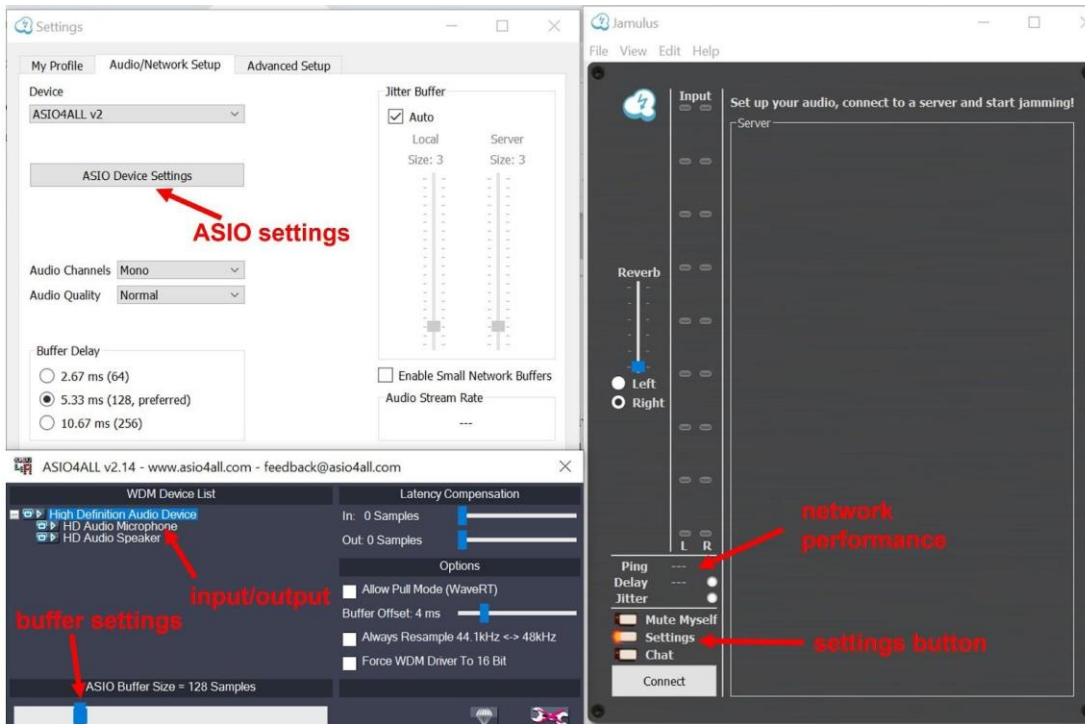
and uses the OPUS audio codec. There is one server running the Jamulus server software which collects the audio data from each Jamulus client, mixes the audio data and sends the mix back to each client. The concept is explained by the following figure.

The simplified core structure of Jamulus starts with a callback-based audio interface which captures audio sample blocks. The audio interface can be a USB microphone, a MIDI interface or audio card output. These blocks are compressed with the OPUS low-latency audio codec and transmitted through the internet using the connectionless User Datagram Protocol (UDP). At the server a set of jitter buffers collect the asynchronous network packets from all connected clients. In the server processing loop, the data packets from each client are taken from the jitter buffer, decompressed and mixed together. This mix is again compressed with OPUS and transmitted to all connected clients with UDP packets. Back at the client, the received server packets are stored in a jitter buffer. On the next audio interface callback, a network packet is taken from the jitter buffer, decompressed and sent to the sound card for output.

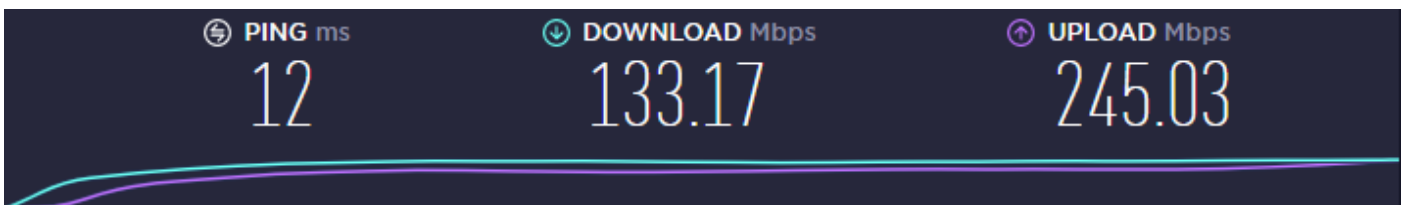


#### 4.2.5 Installation of the experimental setup

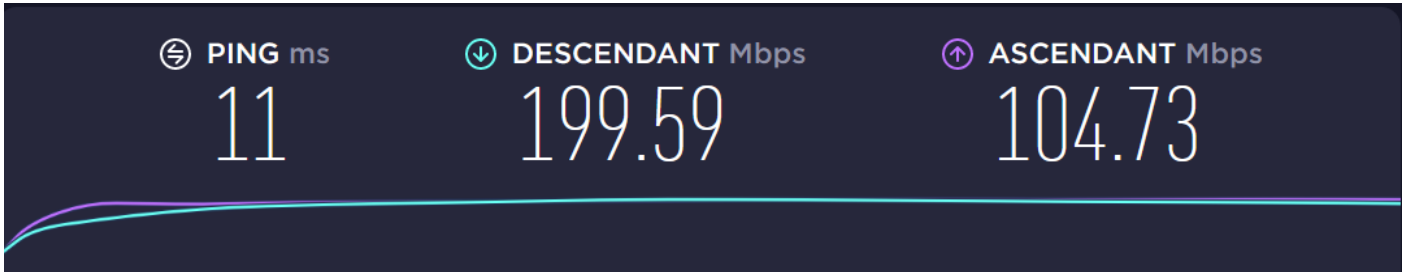
The installation process of Jamulus for multiple platforms is relatively straightforward, according to the website of the software. Depending on the hardware the user would like to use, input and output should be selected in the ASIO settings.



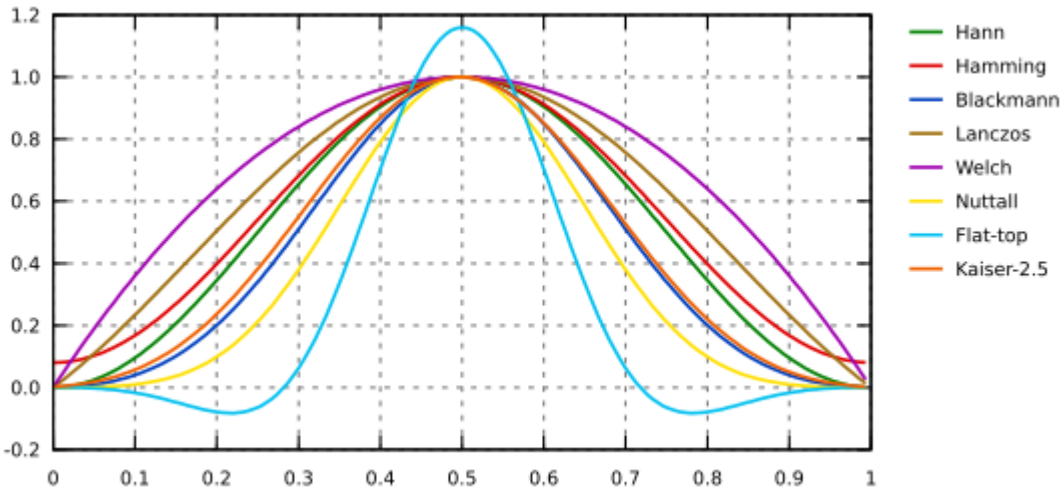
- Basic setup: PC or laptop with budget headphones (with wired) and microphone integrated (or wired). PC configs: Windows / Linux / Mac OS.
- Medium setup: PC or laptop with quality headphones, fast wireless internet connection, USB external microphone.
- Advanced setup: PC or laptop with quality headphones, fast internet cable connection, external audio board, USB external microphone.



Set values for the speed of the connection



PN: wifi (optical fiber)



Windowing: [Transformée de Fourier \(qwyddion.net\)](http://qwyddion.net)

Blackman and Hamming windowing are interesting to avoid or minimize rebounds.



#### 4.2.6 Professional training: case study of ensemble Lira Transalpina

The first use of Networked Music Performance techniques with Jamulus for the Virtual Stage project was carried out by the ensemble Lira Transalpina during early stage of project designing process. The experimentation was carried out by all the members of the ensemble.

The ensemble Lira Transalpina participated in the NMP experiments composed of 4 musicians located at different distances between Italy, Switzerland and France. The ensemble was interested in this technology during the lockdown in order to continue the musical interactions for a chamber music work. The ensemble was interested in a varied and eclectic repertoire ranging from historically informed music to popular songs.

##### **Choosing an NMP tool:**

Solutions based on Networked Music Performance techniques were sought during the pandemic period. The knowledge of the LoLa system (cons. Tartini of Trieste) inspired the use of a web tool allowing remote rehearsal. The main constraint to the use of LoLa is the particularly high cost for a private user, while several higher education institutions use LoLa efficiently. The open source solution offered by Jamulus seems to be a good compromise between quality and digital divide. Lira Transalpina has chosen to carry out its first tests with Jamulus.

##### **Inherent problems encountered in NMP**

During the NMP session, several problems were encountered.

One of the problems with music played in real time over the Internet is latency, i.e. the time lag that occurs when (compressed) audio streams are sent and received by each musician. The effects of delay can be partially compensated for using ASIO4ALL in Windows (ASIO4ALL is already installed on mac and works easily, on Linux the installation and use is more complicated). Note that Jamulus can only work if ASIO4ALL is pre-installed.

Although the small delays (up to about 40 ms) can be perceived as synchronous, longer delays make it almost impossible to play together live. Another problem is jitter effect, a type of packet delay (information that travels over the internet) due to changes in latency over time, which results in choppy or distorted sound. Significant delays can even result in packet loss (perceived as a "blackout"). These problems can be mitigated by delay buffers or jitter buffers (both present in Jamulus), but they then add to the overall round-trip delay and must therefore be balanced.

### **Preliminary tests of Jamulus (Installation, different possible configurations)**

To use Jamulus, a phase of handling is necessary. It is important to know the basic settings in order to limit the problems of echoes, breaks...

Then, to limit the problems of delay or time lag, in addition of using ASIO4ALL, it is necessary that all the members find a server the closest to all the participants of the NMP session. To quantify the time lag, each participant must have a ping as low as possible (25ms or less). Remember that the ping is the duration of a round trip between the point of connection from Jamulus (host) and the server where the participants connect. Jamulus Ping is expressed in milliseconds (ms) and measured by the host server. Thus, the lower the ping, the faster and better the connection.

#### **4.2.7 Distant learning setup: recording a NMP session with video**

In this part, we present procedures allowing to realize a NMP session either with video or without video. The choice depends on the quality of the network. Also, sampled instruments can be used with Jamulus. The section shows the procedure as well.

#### **Procedure for opening a session with virtual instruments and NMP**

- 1) open Jamulus;
- 2) open Reaper with ReaRoute template;
- 3) connect to a server;
- 4) additional step for video connection: open Zoom and connect to partners (sound devices will not work with Zoom, since ASIO is used by Reaper and Jamulus).

#### **Procedure for opening a NMP session with sampled instruments:**

- 1) open MIDI sampler software (Kontakt in our case) connected to a MIDI keyboard;
- 2) load the MIDI instrument in Kontakt (for example the harpsichord Blanchet 1720);
- 3) configure ASIO output on speaker;
- 4) open Jamulus;
- 5) open the Digital Audio Workstation (DAW), in our case Reaper with ReaRoute template;
- 6) connect to a server.

Musician	Location	Network Ping	Download speed	Upload speed	Jamulus Ping	Overall delay	Network quality
Evan Buttar	Den Haag (NL)	9 ms	71 Mbps	28 Mbps	15 ms	33 ms	Medium
Elodie Colombier	Lyon (FR)	5 ms	398 Mbps	274 Mbps	15 ms	46 ms	Excellent
Andrea Bareggi	Neuville sur Saone (FR)	10 ms	42 Mbps	61 Mbps	15 ms	50 ms	Medium

Table - Network data for the rehearsal of instrumental parts of *Aquilon et Orithie* by Rameau

### 4.3 Partial Playback with ListenTo

ListenTo is a software developed to stream hi-fidelity audio and record, even non-compressed audio (depending on the internet connection quality of the user).

ListenTo can be used as a stand alone plugin or inside a Daw, both on Windows or MacOs (for further information, please visit the site of the developer down below: <https://audiomovers.com/storage/pdfs/LISTENTO%20Quick%20Start%20User%20Guide.pdf> )

Also, ListenTo enable us to listen the broadcast simply by Browser on Windows, MacOs, ios and Android: this feature is very useful because many students can listen to the same lesson in different places, or even participate to the rehearsal of an opera.

The procedure we tested involve the use of ListenTo by the Daw of the institute or the teacher, and the students follow the lesson via browser.

This method makes possible to send the audio to all the attendees, which can also play together and listen to each other, however it is not possible for the streamer to receive the audio from the attendees.

This works very well in case the institution or the teacher has a good internet connection while the attendees not.

## 4.4 Best practices for simple and effective recording and video sharing by internet connection

To make a video recording or streaming there are many aspects to consider, from the equipment to the positioning, composition and light to obtain a result that meets our needs.

With the passage of time, obtaining a good visual result is easier and easier thanks to new technologies. Every year new phones come out with more and more performing cameras that are sometimes unrecognizable compared to a film camera for the inexperienced eye.

Getting a perfect image is very difficult, and a professional has to deal with many settings on their camera depending on the location, type of light and content of the video. But it will not be a problem for us because we will rely on the automatic settings of the camera or webcam but with some precautions.

Most important of all composition and framing, and this rule applies whether you are using your phone's camera or if you are using a dedicated video camera.

There are many types of shooting and each one has its name, none are wrong but they must be used depending on the type of video we want to make.

- Close-up
- Medium Shot
- Long Shot

For our use we would need a medium shot as shown in the image:



In this way we can see the whole figure including the instrument and we can understand any movement well. It is important to fill the whole frame from bottom to top with our subject, if it remains in a small part of the screen we will struggle to see well

It may happen that in front of the instrument we have a microphone, starting from this shot we can move slightly to find a compromise in which the microphone is able to pick up the audio well but in the meantime the subject is not covered too much by it.

The background is very important, there must be no objects or people who can distract attention and gaze from our subject.

We can create a themed environment, or else we can keep the background clean and take advantage of an empty wall.

Positioning is also important, for a better result it is better to have some space between us and the background behind at least 3 meters, this is because when the camera focuses on the subject automatically the background will be out of focus and this will give more importance to who is playing and will keep the audience more focused.

We make the most of the ambient light when we do not have the possibility to use dedicated lights. Let's not position ourselves with a window in the background but use it to illuminate ourselves. It would be good to have the window facing us or to the side.

#### **4.4.1. Equipment: Camera, Lights, Computer, Software.**

Starting from the video camera, there are several possibilities depending on the financial availability.

For an institution it is recommended:

- Canon RP with kit lens

This camera returns a professional level quality.

The advantage of this camera is that it can be used as a video recorder, but can be connected via USB to the computer and can be used as a webcam for live streaming.





A less expensive alternative can be the Canon M50.

If the camera does not have the possibility of being used as a webcam we would need a cam link that will allow the computer to receive the signal from the camera and be able to use it on streaming platforms (Zoom, OBS, Youtube)



Using such a video camera also means equipping yourself with some other accessory to make it usable, such as a memory card, a tripod and a spare battery.

The recommended kit for the camera (Institutional level):

- Canon RP + kit lens 24-105mm
- Sandisk SD 128GB
- Spare Battery for Canon RP
- Tripod Neewer or Manfrotto for camera

For students and low budget professional players it is recommended to make the most of available resources such as the computer webcam, or the phone camera.

If we still want to increase the quality, we can invest some money in a USB webcam which will help us to increase the quality considerably.

Starting from the phone, it is recommended to use a tripod for smartphones to keep the shot stable and to facilitate its positioning and choice of shot.



It is important to use the rear video camera of the smartphone if we want to get the highest quality, but if we need to see each other in real time then we can use the front camera but giving up some quality.

On many computers the built-in webcam doesn't have enough quality, so an upgrade is the Logitech G920



Once connected via USB it will be automatically recognized by the computer and ready for use.

#### 4.4.2 Lights

Having the ability to light the scene to our liking is one of the biggest advantages to drastically increasing the quality of our videos. Sometimes the environment allows us to obtain optimal lighting without too many thoughts, but unfortunately this is not always the case so we would need to study the location and make the most of it, or better still equip ourselves with dedicated lights.

There are rules to be respected for the positioning of the lights, but with a little experience we can try to create different compositions to convey emotions depending on the type of video we want to create.

Let's start with the use of ambient light, it is important to try to have as much light as possible if we want to record a video as a tutorial in which it is important to see each step well.

We turn on the lights of the room we are in or position ourselves near a window so that it lights up our face.

To get the most out we would need to use dedicated lights.

For institutional level:

- Godox SL60W / Amaran 100d / Aputure 120d (one of them, they are very similar)
- Godox / Aputure / Neewer → Softbox Bowens Mount

The lights listed are very similar to each other. Once turned on they produce a very strong light coming from a very powerful led, so it will be necessary to diffuse the light through a softbox that will attach itself in front of the light through its attack called "Bowens mount"





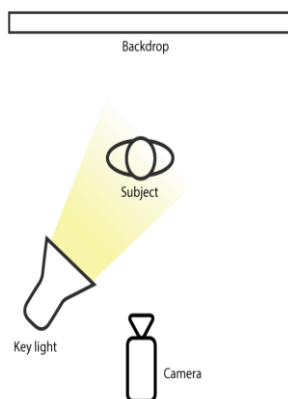
The larger the softbox and the more the light will be diffused, a softbox with about 80 cm in diameter is recommended at least if the subject is a person who is playing.

A cheaper lighting kit is recommended for students, but it allows to obtain a good result:

- Neewer / Godox Softbox lights kit



The light should be positioned slightly offset to one side of the subject but always remaining in front of the subject as in the illustration:



It is recommended to have additional lights of different types such as led panels to complete the lighting of the scene and make everything brighter. We can use the softbox to illuminate the subject, a led panel to illuminate the background, another light to illuminate the other side of the person. It is important, however, that the main light is the first light we talked about that illuminates the subject.

An even simpler and cheaper solution remains the ring light, easily available and not very expensive, but it is the solution with the least quality of all.



#### 4.4.3 Computer

The recommended computer depends on the type of work we have to do: if it is streaming on Zoom via webcam or camera, we can use a mid-range computer such as the Huawei Matebook D14, D15, D16.

In that price range we find computers that can also edit videos recorded with a webcam or smartphone.

To edit videos recorded with a high-end camera like the Canon RP, you need a much more powerful computer like an Asus Rog or a Macbook with an M1 chip.

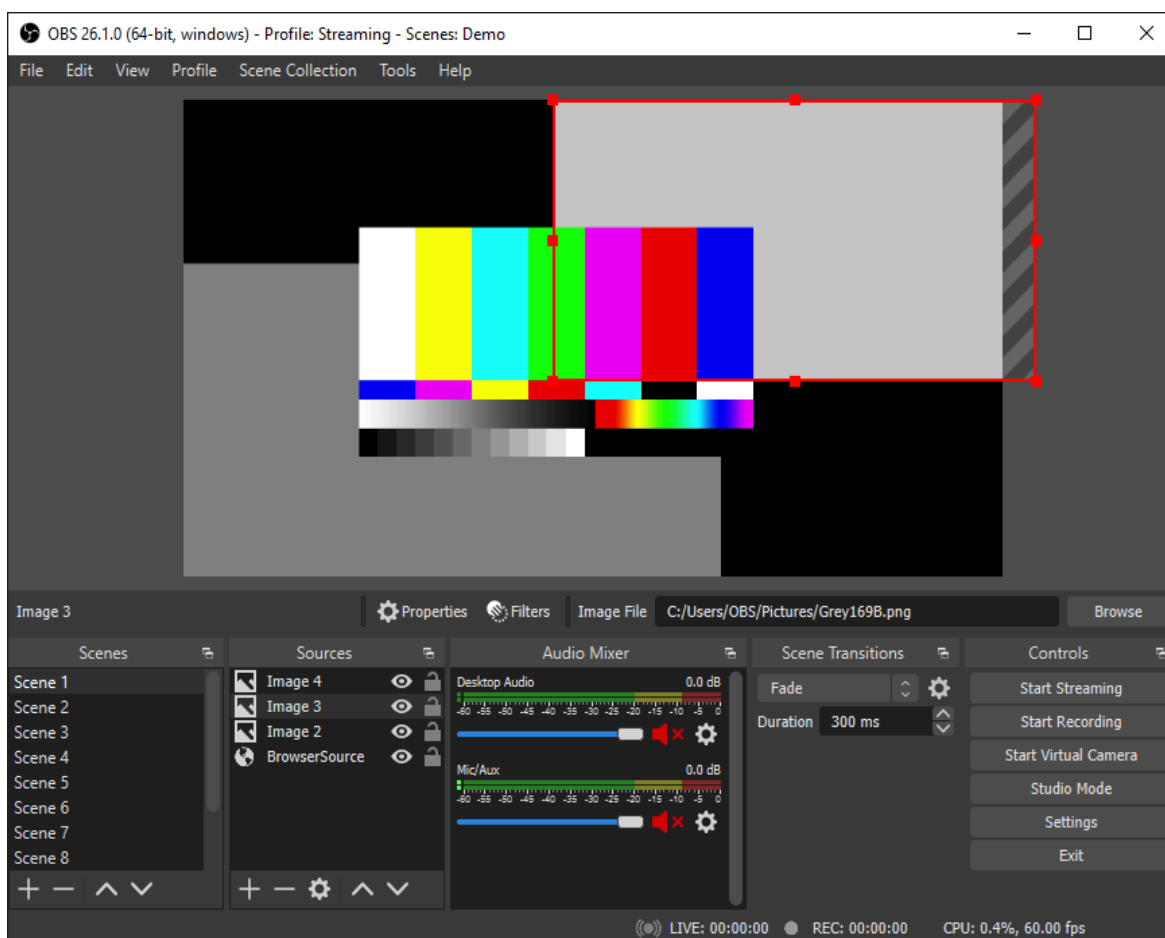
The recommended computer (Institutional level):

- Asus Rog / Macbook M1



#### 4.4.4 Software

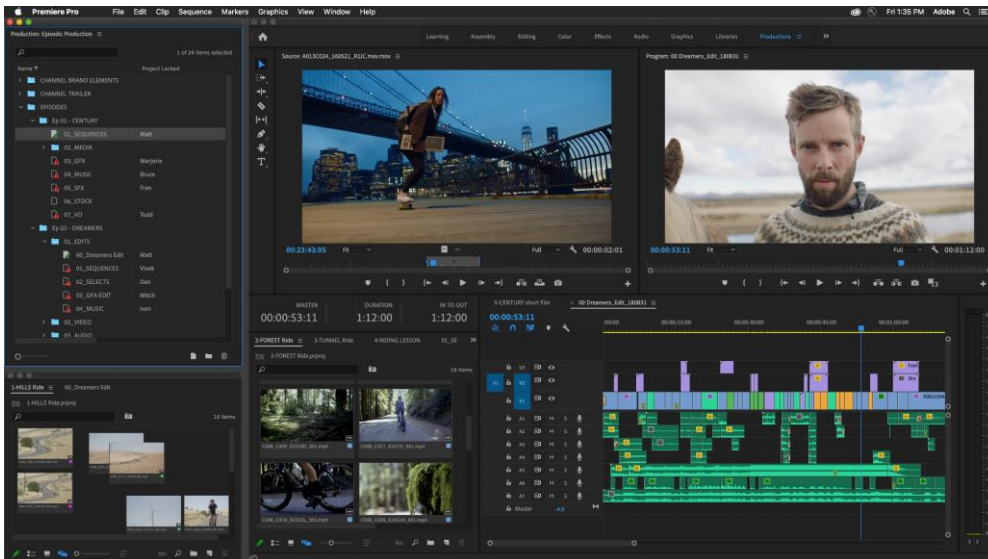
For streaming the best program is OBS studio, available for Windows, Mac and Linux. It gives the possibility to have complete control in the audio and video settings for streaming, you can connect through this program to other applications for online connection such as Zoom, Youtube, Skype and many others.



You have the ability to manage scenes, share your screen and be shot simultaneously from multiple angles if you connect multiple cameras. it is recommended for everyone.

For editing there are different programs, some are paid and some are free, but I will list the best 3:

- Adobe Premiere Pro (Windows and Mac)



- Final Cut (Mac only)

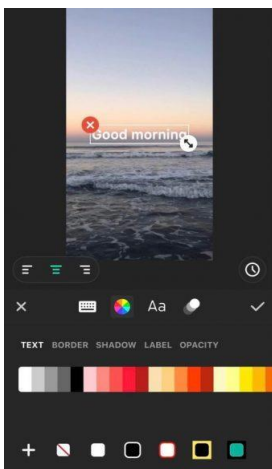


- DaVinci Resolve (Windows and Mac) (FREE)



In case you have a fairly powerful smartphone such as an iPhone 11/12/13 or an Android High-range or a tablet / iPad, then through some free downloadable applications it is possible to edit recorded videos with your phone:

- inshot (Android and iOS)



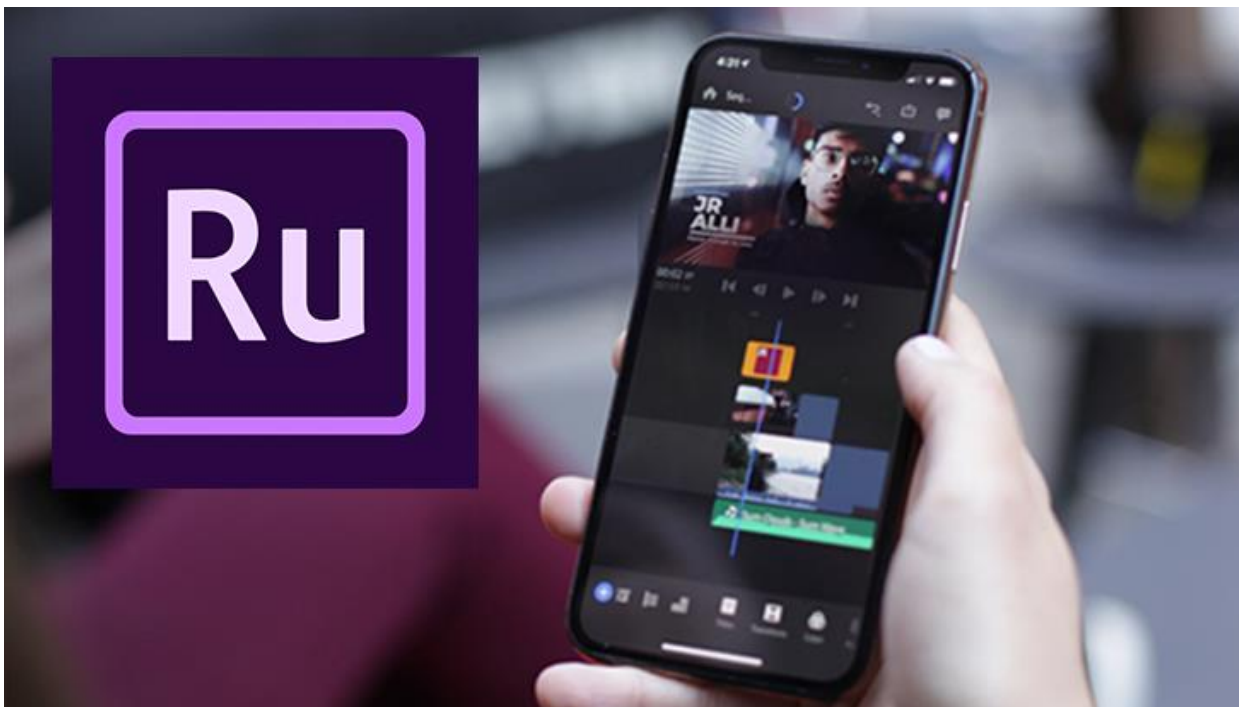




- iMovie (iOS only)



- Adobe Premiere Rush (Android and iOS)



In Virtual Stage the project was carried out through the use of:

- Camera Panasonic GH5
- Leica 12-60mm f2.8
- Neewer LED panels
- Black Background

Editing and post-production was developed through DaVinci Resolve and Adobe After Effect.





In this case we have decided to use a green background to then be able to replace the background in the editing phase.

The paper background gets dirty and slowly deteriorates until the moment when it is necessary to replace it, but it does not create wrinkles and it is easier to illuminate it evenly.

It is important to brighten the background trying not to cast shadows on the green. Good light will make the work much more accurate.





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