

Legato: an Online Platform for  
Virtual Collaboration of  
Amateur Classical Musicians

Jiyoung Lee

Department of Creative Design Engineering

Graduate School of Creative Design Engineering, UNIST

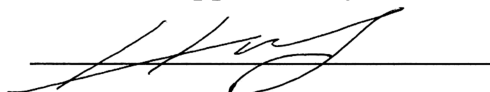
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Jiyoung Lee

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Advisor

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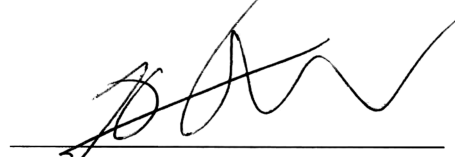
This certifies that the thesis of Jiyoung Lee is approved.

07/01/2021




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Adviser: Hwang Kim



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Seungho Park-Lee



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KyungHo Lee

three signatures total

## EXECUTIVE SUMMARY

Legato is a digital service platform to enhance the collaboration process for musicians in an orchestra context. The advent of new digital technologies, our daily lifestyle is with the digital environment. The present era of Covid-19 in the world is accelerating this digital transformation, and new experiences are emerging. Especially, the pandemic has attacked to the classical music industry, which has focused on the offline experience. The project scope is mainly focusing on classical musicians who collaborate for musical performance in the digital native. In the classical music field, three factors are creating music, which is a relationship between the audience, composer, and musician. In particular, it is aimed at amateur musicians such as people who take music as a hobby or young students who have little practical experience. This project proposes an online platform for the digital transformation of existing offline classical collaboration processes. The online platform aimed to allow musicians to share before and after their careers in music collaboration. Legato collects, analyzes, and reflects data on musicians' practice in online music collaborations. Moreover, Legato provides various classical music content and shares the overall music process at musicians' convenience. Additionally, Legato examines gaps and maneuvers, both online and offline music practice, to improve performers' experiences.

Keywords: Digital Transformation; Online Platform; Virtual Music Communication; Classical Music;

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# 1. INTRODUCTION

## 1.1. Motivation

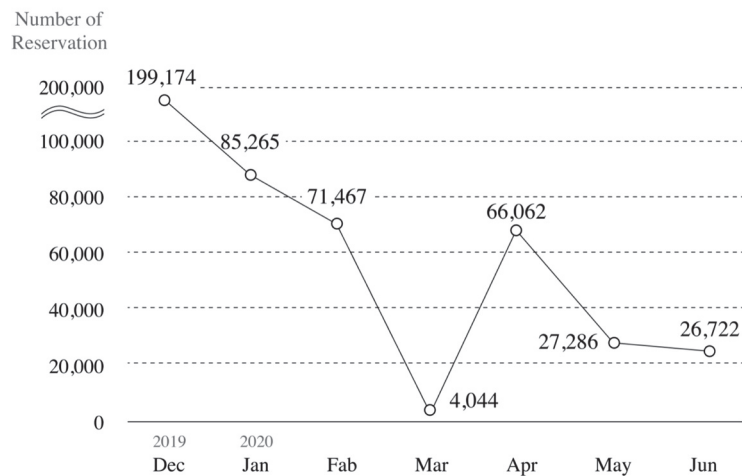
Collaboration using musical instruments is one of the interesting activities with other people. Musical collaboration like an orchestra makes the music richer and fulfills each other's deficiencies when performing together than when individuals. There was a short violin experience in the orchestra club in UNIST, which gave some a new perspective insight into the teamwork due to musical instruments. There is a possibility that the ecosystem of conservative, but systematic classical music can be offered a better experience, with a specific context in identifying the user experience. These are the reason why this project topic is about collaboration in classical music.

## 1.2. Background

The advent of new digital technologies, such as social networks, mobile applications, agent-based intelligent systems, and big data applications, have revolutionized our daily lives (Adhiarso et al., 2019). Digital products and services continue to provide users with more useful, accessible, and emotional experiences through the digital revolution (Goodwin, 2011). The present era of Covid-19 in the world is accelerating this digital transformation, and new experiences are emerging across the domestic, education, government, and business sectors. Digital transformation can be defined from technological, organizational, and social aspects. In the social aspect, digital transformation is a phenomenon that improves the user's experience due to digital technology and thereby affects all aspects of human life (Reis et al., 2018). This digital acceleration from pandemics has the potential to continuously, not just a temporary phenomenon. For example, conferences and events that have been held offline are being held online under the name of webinars, and it is predicted that the trend will continue to intensify even after the pandemic ends (Microsoft, 2020). Besides, digital changes in everyday aspects, such as meeting someone to socialize or collaborate, are also rapidly taking place. These aspects suggest that the next generation of digital technology and software applications will further transform people's markets, society, and daily lives (Malter & Rindfleisch, 2019).

Digital technology has caused a new generation of musicians or audiences who are getting used to interacting with each other, sharing their daily life's activities on social media platforms and services (Reis et al., 2018). Although digital technology has caused many changes in many areas, the classical music field has been reluctant to its adaption. While the audiences and musicians remained the digital natives to the cutting edge of the 21st century's digital generation and the classical music field was stuck in the 20th-century style and could not get out of the concert hall of the previous generation (Born & Devine, 2015). However, the Covid-19 impact has brought such an upheaval to the conservative music

scene where concert halls and their experiences have been transforming into online spaces (Cho, 2020). This pandemic has attacked the classical music industry, which has focused on the existing offline classic concert. The number of reservations of concerts was continuously decreased (Baek et al., 2020). In the classical music area, the concert was continuously decreased compared to the end of 2019 (KOPIS, 2020). In offline concerts, musicians usually did activities offline, not online, due to a sense of realism. However, the most of concert has been canceled as the impact of the pandemic, and many musicians have frozen in their field because they cannot play together in the real world.



**Figure 1. The Number of Reservations of Classical Concert in Korea (December 2019 to June 2020)**



**Figure 2. Rotterdams Philharmonic Orkest (Left), and Colorado Symphony (Right)**

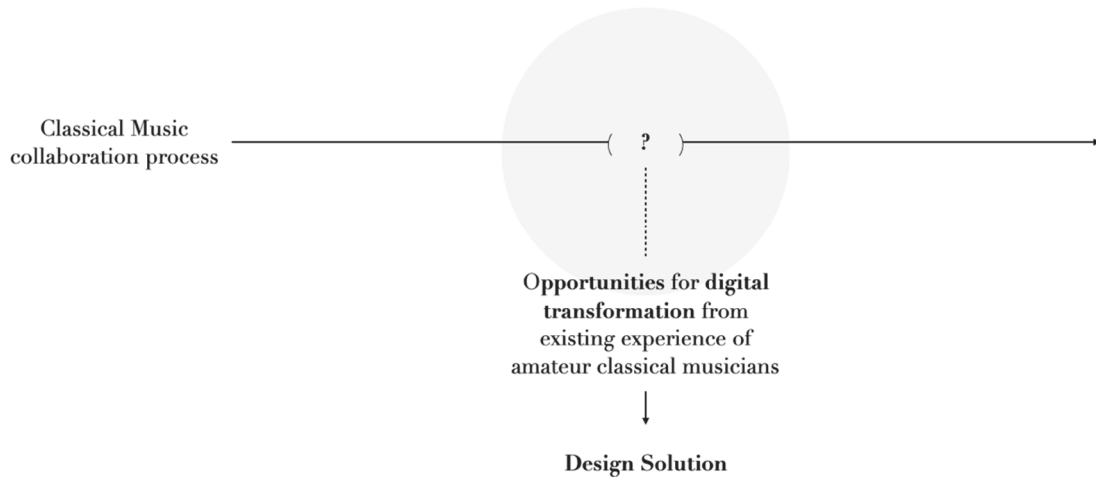
The world's top three symphony orchestras - the Berlin Philharmonic, the Vienna Philharmonic, and the Royal Concertgebouw Orchestra - have been providing live streaming services through official YouTube on their official channels. Besides, New York Philharmonic, Colorado Symphony, Rotterdams Philharmonisch Orkest performed virtual orchestra based on social distance. The remote orchestra concert, which was first introduced in 2014 under the name of "NTC Wi-Fi Orchestra" through composer Ljov, has recently reappeared. This is not only limited to such large orchestras, but also small-scale music groups are actively trying to stream or collaborate through YouTube and personal social media channels. As such, transformation is taking place in a new way in the music world through the currently available digital technology. From this perspective, it is necessary to design approach for classical music collaboration toward digital transformation in this pandemic situation.

### **1.3. Project Scope and Audience**

The project scope is mainly focusing on classical musicians who collaborate for musical performance in the digital native. In the classical music field, three factors are creating music, which is a relationship between the audience, composer, and musician. In particular, it is aimed at amateur musicians such as people who take music as a hobby or young students who have little practical experience. Music delivers composers' interpretation to musicians, and subsequently, the musicians interpret the music is based on their understanding and collaboration. The audience is exposed to musicians' music through a channel, such as a stage or online platform. In addition to the channel where the two groups of musicians and audiences intersect, the interpretation in which the audience accepts music and the musician's process prepares music to exist individually in each factor. There is a slight shift in online platforms in terms of interpretation and musician's channel, and in the preparation of the music that is being made, it has recently been shown as a virtual music collaboration.

The main focus of this project is to address the digital transformation in the classical music area for collaboration among musicians. In response to this digital transformation, the current research is accompanied by three aspects: the timely necessity of digital transformation due to the Covid-19 pandemic, the opportunity such as the national digital new deal support policy, and the feasibility of the digital generation transformation with digital literacy. Many classical musicians are working online and performing in virtual environments. Depending on the media, platforms, and content they have encountered, today's MZ generation who were born in the 1980s and early 2000s shows different characteristics from the older generation (KOCCA, 2019). This emerging enhancement of classical culture in the digital world is a turning point for the digital generation, the MZ generation, and the digital introduction of classical music. It presents a new direction in digital transformation in the field of classical collaboration.

## 1.4. Project Objectives



**Figure 3. Project Objects**

The digital transformation of the previous offline classical music collaboration process into online platforms has the potential for archiving volatile information, such as sounds and feedback in the music collaboration process. Archiving these digital data can help organize personalized information and, by extension, expect effective communication in the music field. The digital transformation is not about delivering all of the experiences in the classical music field, but about anticipating synergy between online and offline experiences by digitizing vulnerabilities in offline experiences. The primary goal of a digital transformation is to effectively accumulate musical data in the process of music collaboration, as well as to enable users to utilize the archival data. The research aim of the present project is to propose a new context for the new digital-based music preparation of the classical music collaboration process through design based on the existing context. The objectives of this project include the followings:

1. To identify the opportunities for digital transformation from the existing experience of amateur classical musicians
2. To provide applicable design outcomes based on seizing the opportunities for digital transformation

## 2. RELATED WORKS

### 2.1. Change of Classical Music in Pandemic

#### 2.1.1. *Digital Transformation and Classical Music*

New media influences behavioral changes in media use that affect social change, culture, economy, politics, etc. (Adhianto et al., 2019). As technology progresses, people's lives continue to evolve as a result of digital transformation. Digital transformation is referring to using new, fast, and changing digital technologies to solve problems and reduce dependence on owned hardware users while increasing reliance on cloud computing-based technology. This project will propose services using digital platforms as a digital solution. Digital transformation alternative a wide area of offline experiences to the digital platform, Pandemic has had a dramatic impact on the global economy, corporate activity, and people. Digital transformation can make many businesses adjust and overcome the situation caused by the Pandemic (Almeida et al., 2020). Pandemic is a catalyst that accelerates the emergence of the digital economy and increases this effect (Civelek & Xiarewana, 2020). All aspects of political, social, and economic activities are rapidly being incorporated into digital economies, such as non-face-to-face and online (NRF, 2020). We live in a largely digital world, but not yet fully digital, which makes it very fascinating. For those engaging with millennials today, who are mostly too young to recall the pre-digital period, evidence of the rapid transition to the digital age is evident. They prefer to roll their eyes because, before cell phones (much less smart ones), digital cameras, email, the Internet, e-commerce, or social media obviously cannot believe tales of the 'old days' of the 1990s. Because so many facets of life are now online, it is difficult for digital natives to imagine how the previous generation was able to handle it (Malter & Rindfleisch, 2019). Markets, culture, and daily life will further shape the next generation of unimagined digital technologies and software applications.

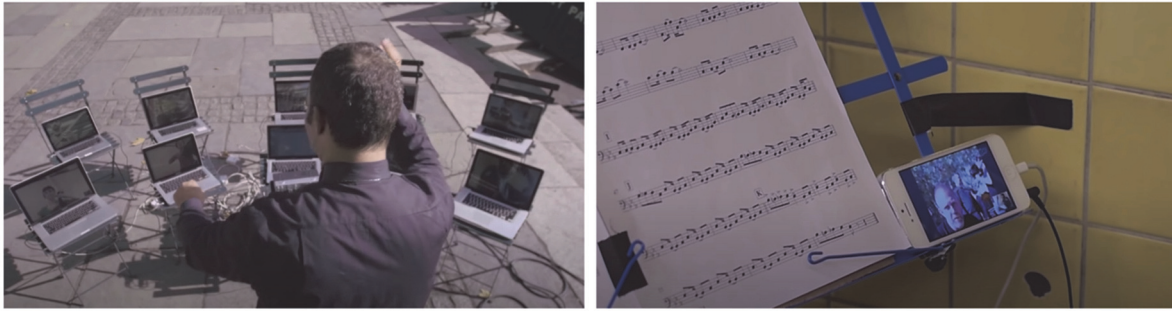
Technology has helped individuals interact with music and experience music in ways previously impossible. Mobile computing applications can be provided as a means for individuals to understand musical skills. Accessible through streaming music services and various music libraries (Bauer, 2020). We can consume and experience music context in various ways through technology. In performance, musicians usually did activities offline, not online, due to a sense of realism. However, the impact of the pandemic, a lot of concerts have been canceled, and many musicians had frozen in their field because they can't play together in the real world. When people cannot meet directly, such as distancing like the current situation, alternatives are online tools like zoom for meeting together. Like this, digital transformation refers to the use of digital technology to bring business or people's experiences to the digital environment. In particular, the proportion of remote work has increased because people have to work.

Classical music is played on classical instruments. The ability to make music as an ensemble in real-time is hard in the Pandemic situation. Some musicians create an orchestra video collecting other musician's video clips. Music teacher uses video calls to teach musical instruments and give feedback to students in real-time. These changes are the beginning of the digital transformation of the classical music collaboration field, which may become more natural through the digital generation having high digital device literacy.

### ***2.1.2. Classical Music Collaboration and Telematic Performance***

There are benefits of ensemble music-making that are *Social Impact* that building social networks, *Personal Impact* that improve individual skills and confidence, and *Musical Impact* that has technical and creative outcomes. The performer's performance improves their musical ability, but also ensemble can help social and personal skills, form the community's, and produce creative musical results (Kokotsaki & Hallam, 2011). Social and interpersonal relationships are important factors in orchestra, and musicians emphasized the importance of maintaining good social relationships with colleagues to create a good environment for achieving excellence (Dobson & Gaunt, 2015). For amateur musicians, they are placed in exceptional cases about the situation. In the study of Goodrich, Adult amateur musicians need to commit to spending extra time for rehearsal or practice and concert because they have another job. For this reason, They also have trouble with the limitation of time and place (Goodrich, 2019). Also, young musicians and amateur musicians who live geographically far away often do not get the opportunity to produce ensemble together. That is, the time, cost, or physical location of the travel for the ensemble as face-to-face can make it impossible to participate regularly. Unlike famous professional musicians, they are hard to get financial support (Rofe, Murray, et al., 2017).

Online music collaboration has the difficulty of ensuring technical stability. The music ensemble should be accompanied by the sound of each instrument without latency, and this should be delivered to each other in real-time without delay. There are several technological studies about online music collaboration. Project "Signal Strength" conducted 11 musicians and one conductor for musical collaborating through nine different New York City subway stations connected over public Wi-Fi. They used Wi-Fi to nine different subway stations, simultaneously connected with Bryant Park's composer Ljova. He conducted for performing live connections with musicians. In this project, a test result of 0.5 seconds of error connected during performing.



**Figure 4. NYC Wi-Fi Orchestra**

Project "Online Orchestra" conducted an online music collaboration for amateur musicians and children in remote locations with few musical collaboration opportunities over the Internet between October 2014 and July 2015. As a result, there was an issue of latency, but there were opportunities for new approaches in telematics performance and identified the potential to enable widespread participation (Rofe, Geelhoed, et al., 2017). When exploring the mobile music performance paradigm, future work should focus on the social and geographical elements of the performance (Oh et al., 2010). Although the musical collaboration process's behavior patterns cannot be fully defined, exchanges in social aspects are an important role. Compared to traditional performance, such as this actual face-to-face exchange, it cannot completely replace everything that natural space. Online musical collaboration has posed a challenge because it will never feel like real music-making. "Remote communities to the wide-ranging potential benefits of participating in ensemble music-making" (Rofe, Murray, et al., 2017).

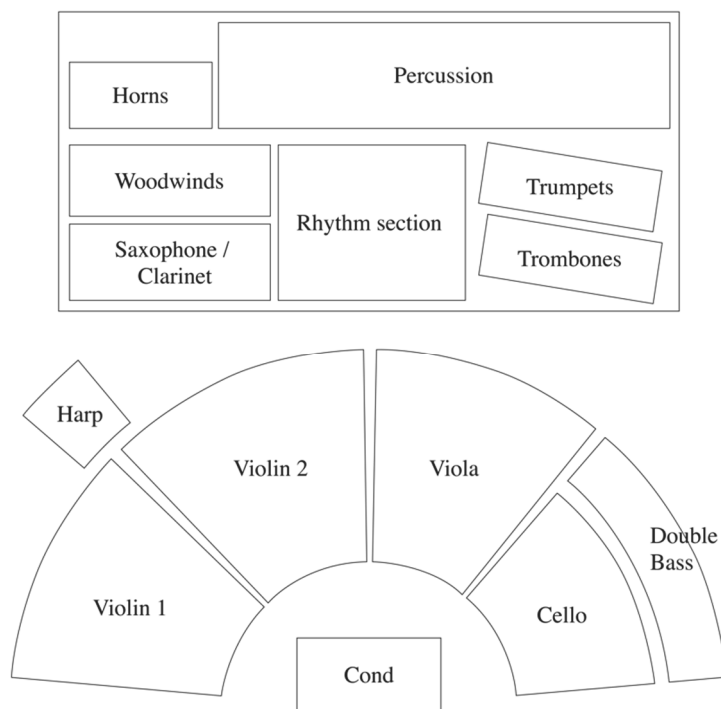


**Figure 5. Online Orchestra**

The musical collaboration for music-making is important, but the way of delivering music through a digital channel is also one of the important factors. Typical orchestras performing in the concert hall have to arrange sections in consideration of the performance space and the characteristics of the sounds of each musical instrument (Absil, 2008; Meyer, 2009). The orchestra's seating arrangement is constructed face to face with the seats for the audience who is the listener. The arrangement of sections is important, and instruments that have less volume sound located to the front, based on the sound being



transmitted in proportion to the distance. And at the center of it all is a conductor. The orchestra's performance space has a particular meaning. The orchestra section arrangement has been changed a lot over a long period and has been varied according to the characteristic of the orchestra group or music. The size of the orchestra has the obvious factors of the seating arrangement, the relationship with the conductor and each section, how the sound is conveyed to the audience, and whether the form is visually good in the audience's perspective (Ford, 2019). There are no fixed rules about the seating arrangement for orchestras, but the structure of studio orchestra seating arrangement (Absil, 2008) is proper for amateur orchestras that play various genres of music on classical instruments rather than typical orchestra. (See Figure 6).



**Figure 6. Studio Orchestra Section Arrangement**

There is a way in which synesthesia sounds delivered by these orchestras can be implemented through sound space as spatial audio in the way that is delivered. The spatial audio called 3D audio effect is usually used in Dolby Atmos of Apple Music that supports all AirPods, and the latest versions of iPhone, iPad, and Mac (Apple, 2021). Spatial audio technology analyzes the principle of perceiving space characteristic to reproduce auditory information as similar to reality as possible and acquires, analyzes, and reproduces spatial audio for sound to feel realistic sounds and spaces corresponding to the position and movement of the listener (Lee et al., 2019).

### 2.1.3. Digital Music Score and Digital Music Libraries

Typical classical music is often referred to or played by classical musicians such as Mozart and Bach, and a program aimed at collecting music in this non-copyright state into a library is called IMSLP “The International Music Score Library Project (IMSLP), also known as the Petrucci Music Library, is a crowdsourced database of public domain music score.” It aims to make music accessible to everyone and is a library of works (Hoelscher, 2017). Music score also has been digitized well through various software. MusicXML that was open format that displays music score, enables information exchange and file compatibility between different music programs. It can easily be edited to other software, and it can create a different type of program or service. Digital software includes *Musescore*, *Sibelius*, and *Finale* for editing music score. Unlike *Sibelius* or *Finale*, music score editing software, *Musescore* is open-source software that can easily edit digital music score and free (Watson, 2018). *Musescore* supported a variety of files for input so, and it can easily be edited to other software, and it can create a different type of program or service. Digital music score is one of the opportunity of digital transformation in music fields.

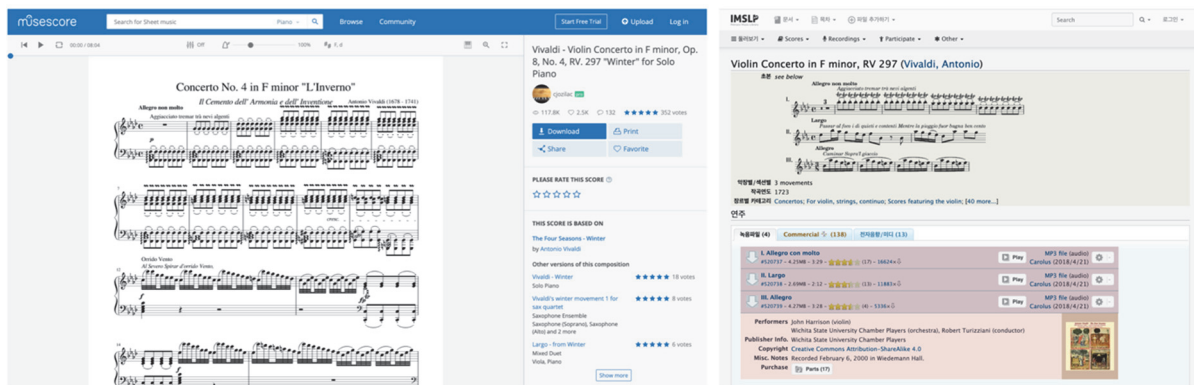


Figure 7. Musescore (Left) and IMSLP (Right)

## **2.2. Conclusion of Related Works**

The acceleration of digital transformation due to pandemics is rapidly occurring, resulting in online attempts at classical music fields like a virtual performance of musicians. Although there are many attempts to be a potential online collaboration of music, there is an absence in the connective part of the overall user experience that is short-term and encompasses the characteristics of music collaboration. This project proposes a new context for the new digital-based music preparation of the classical music collaboration process through design based on the existing context. While providing a new experience, the new experience is to discover the digital transition opportunity factor in the advantages of a new digital context for classical music, rather than a digital transition in all parts. To propose a complementary solution for the digital-based classical music collaboration process for amateur musicians rather than replacing the existing experience.

## **3. DESIGN APPROACH**

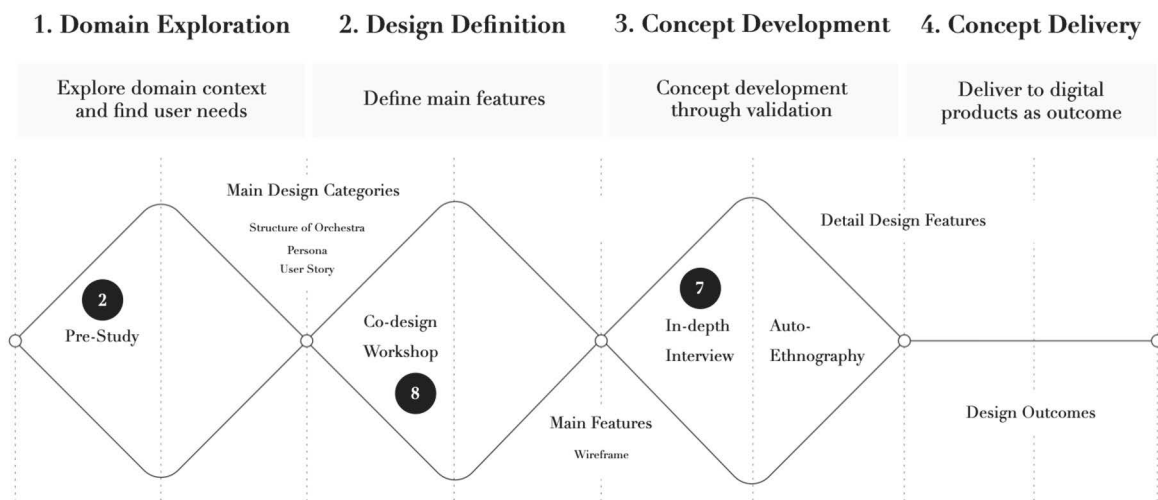
### **3.1. Double Diamond Model and Agile Design Process**

The design approach adopted in this project aims to build a clear understanding of the existing offline classical music system and derive opportunities for digital transformation to efficiently increase the user experience as a design outcome. For this purpose, firstly the existing design approaches are studied. Based on the well-known IDEO's diamond design process, there are various design approaches to similar concepts combined with the design process of the innovative design approaches. The four steps are exploring, spreading, and defining the insights is reduced, and then re-confident and convergent through concept verification and eternity (Yu, 2017). In the course of the first diamond, Discover and Define, design the right things, such as finding the object, method, and clear logic of solving. The second diamond, the development and delivery phases, is design things right, which form new designs for user experience and user interface design components based on detail concepts.

The traditional agile process is to provide software results to customers by quickly interacting. That could be a user-centered design conflict based on user research (Silva Da Silva et al., 2011). It was adopting these two points of view combined the advantages of the rapidly iterative agile process with the contextual elements from user-centered based design to apply the agile approach in the user experience element and conceptual design phase. With the above processes, the following modified design process model is proposed for a detailed design process to achieve the aims of the current design approach.

### 3.2. Project Process

Based on the above processes, the proposed design process was established for this thesis. It includes four steps: Domain Exploration, Design Definition, Concept Development, and Concept Delivery. The process has three diamond structure that works with a mechanism presented here (See Figure 8). Firstly, repeat the process of repeating diffusion and reduction. Secondly, after detecting the problem, find the key insight based on understanding the contact and the user is going through the extension. The main features are composed by finding common denominators of ideas and reducing them again based on the discovered key insight. In the third phase, after the main features were verified, the final concept is designed based on the verification process's insights. The whole process takes the structure of a double diamond. The double diamond process of diffusion and convergence applies both in terms of the project's overall structure and in terms of the detailed processes within each process.



**Figure 8. Three Diamond Structure of the Modified Design Process**

The framework for the detailed design process of diffusion and reduction works follows the elements presented in the framework. Each design stages are presented. These stages were later incorporated into the design approach in which each stage was conducted based on the existing design methods. Instead of completing each progress user study data separately, the design process was carried out by accumulating raw data from the previous data according to the purpose of each progress. This design process was not linear in all processes but sometimes paralleled.

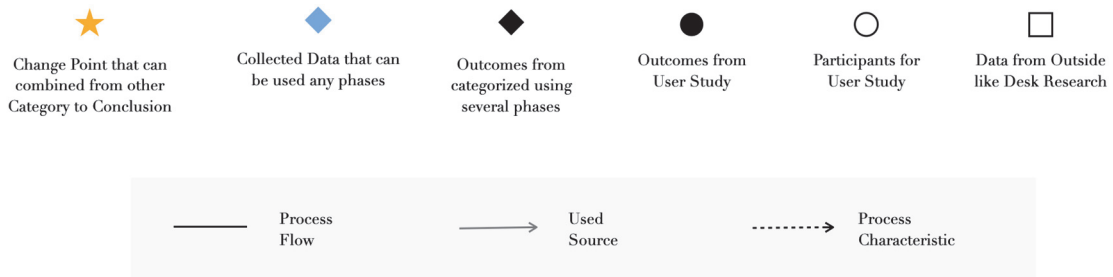


Figure 9. Guide of Detail Process

### 3.2.1. Domain Exploration

This is the exploration part that is the purpose of an overall understanding of the existing offline music collaboration process. To this end, the information spread through desk research and online observation to observe online music-related communities. Moreover, based on this, the virtual persona was set up based on classical musicians' information with digital literacy and social media usage frequency. At this stage, the purpose is to find key findings for the existing offline music collaboration process experience. Main user stories were then derived from the key findings.

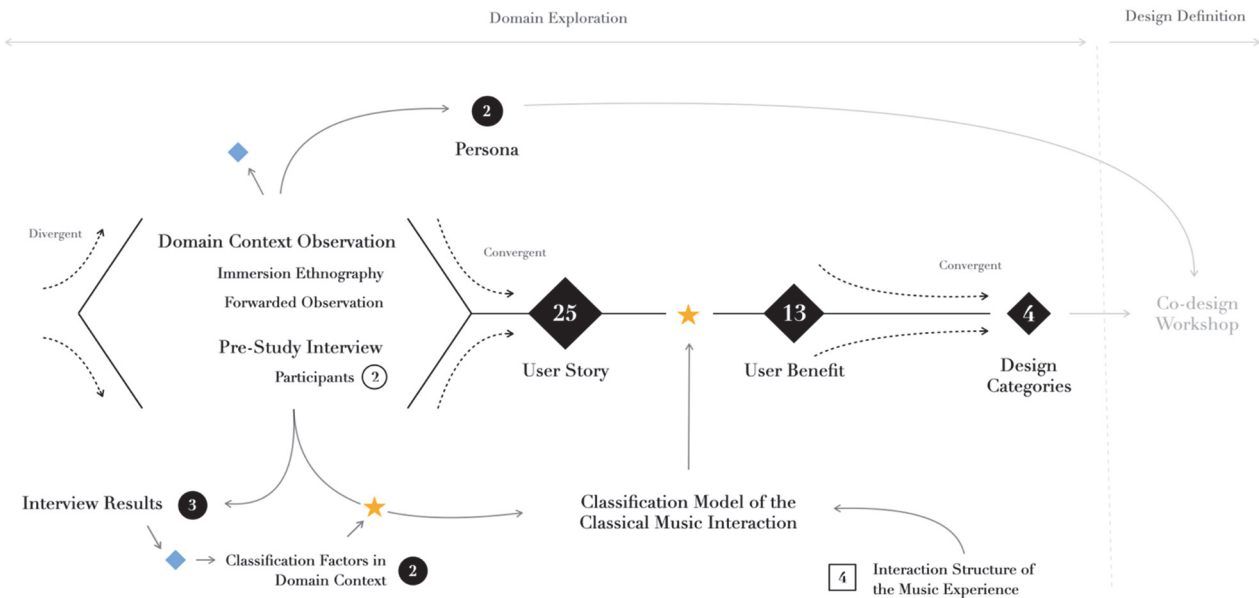
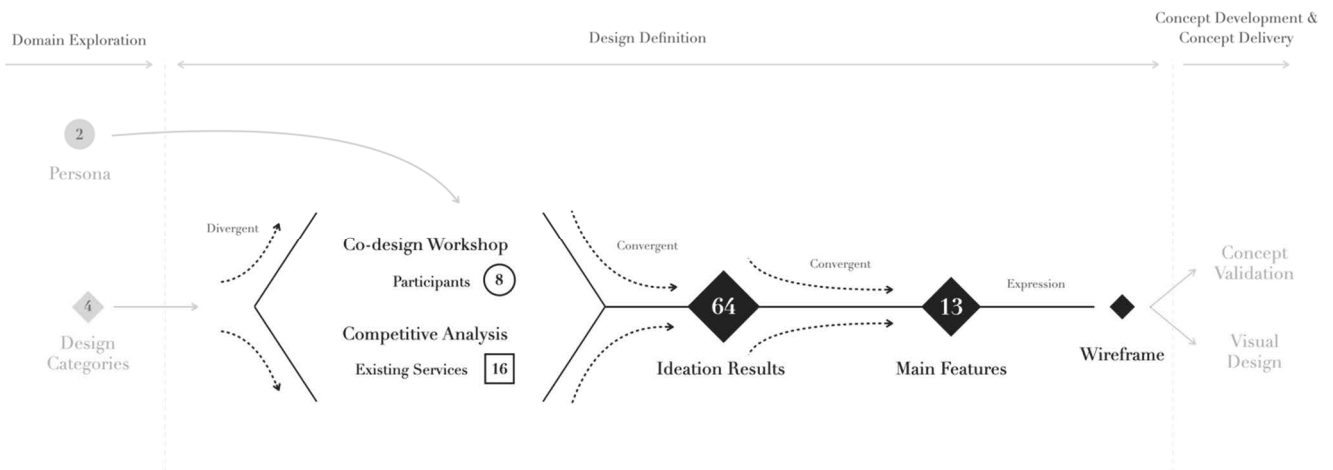


Figure 10. Detail Process of Domain Exploration

### 3.2.2. Design Definition

Based on the main user stories, conducting a co-design workshop for spreading ideas, the main features were identified through the categorization process after listing up the ideas. In this process, features that may be digitally transformed into online platforms were selected from existing user stories.



**Figure 11. Detail Process of Design Definition**

### 3.2.3. Concept Development & Concept Delivery

After investigating the features of other competitive services based on key features, a verification interview is conducted to evaluate essential screen main functions. The concept development process was carried out to refine the idea. In the validation interview, wireframes and concepts defined in the main feature were verified, and additionally, overall interviews were conducted in the user experience. The design outcomes were revised based on validation results. Detail screens are organized based on defined detailed features that were revised. The identity of the service platform was expressed in keywords and mood boards, and essential elements such as colors and fonts for the GUI were established.

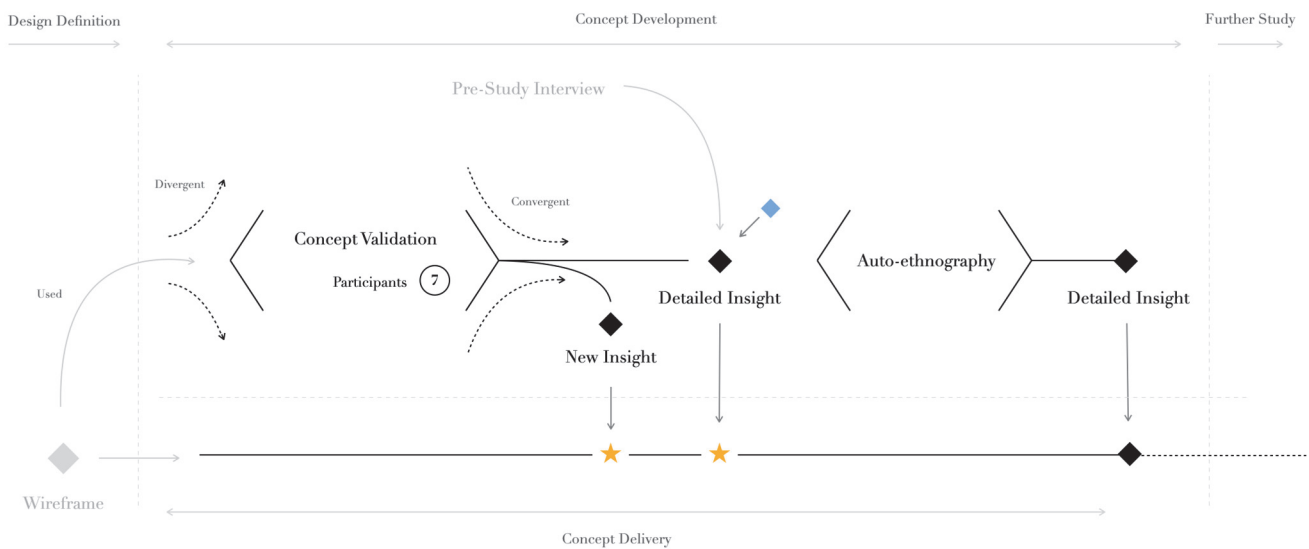


Figure 12. Detail Process of Concept Development and Concept Delivery



Figure 13. Legato

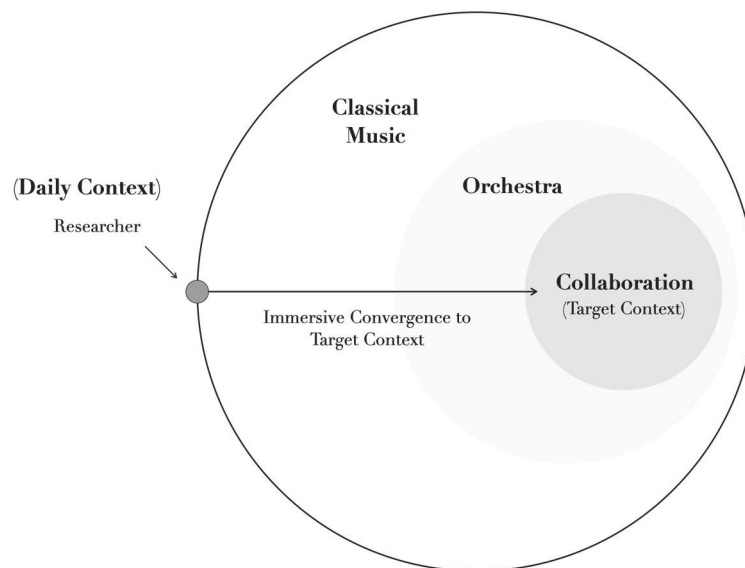


## 4. DOMAIN EXPLORATION

This is the Domain Exploration chapter that aims to understand the existing offline music collaboration process. At this stage, the purpose is to find key findings based on understanding the existing offline music collaboration process experience. For understanding of domain context: classical music collaboration, it was used online and offline space for observing and also was conducted pre-study interview who has experience about orchestra. Main user stories were then derived from the outcomes of the analysis.

### 4.1. Domain Context Exploration

In ethnography, which was used to understand users' needs through observations of the context, is helpful in the early stages of the project, allowing them to produce more reasonable products and services through insights into the context of the problem. Ethnography has the disadvantage that it is not easy to do in a short period (Marsh, 2018). This project follows a modified agile design process, so it sought to use a digital environment like online media to compensate for these problems of ethnography that need to observe an extended period to derive hypothetical user needs.



**Figure 14. Immersive Convergence for Domain Context Observation**

In domain context exploration, it has proceeded with observations in convergence from a wide range of related domain contexts: classical music field in audience aspect to reach the target context that is classical music collaboration in musician aspect corresponding to the project's scope. Observing everything within the context of project is useful for getting new ideas about things that do not exist

(Kumar, 2012). The first approach was to make a wide range of basic approaches to classical music in general, starting with participation in concerts as an audience not related to the classical music field. The following approach understood the orchestra and finally reached the convergence of the range of observations until the target context with the classical music collaboration. For this, it was exposed the environment during project for immersive about context using digital environment. The cultural anthropologist, Margaret Mead mentions “Only by immersing into the daily lives of their new customers can they hope to understand the vastly different behaviors and values” (Kumar, 2012). It used immersion techniques in everyday life. By the standards of the digital generation, everyday life has a different concept from the past. The digital environment, unlike the past, is now a lifestyle in our daily lives. We spend most of the day with digital devices like smartphones, and we also take advantage of this to enforce immersion environment exposure using social networks like Facebook or Instagram. In this perspective, the various type of information provided from the digital environment was utilized for immersive ethnography research in this project not only offline environment. That was two ways in domain context exploration that are 1) *Immersion Ethnographic using Digital Environment in Daily Life* and 2) *Forwarded (Online or Offline) Observation about Domain Context*.



**Figure 15. Valentine’s Day Concert at Seoul Art Center (Left), Conductor Anu Tali Talk Concert (Middle) and Violin Community Worldwide in Facebook (Right)**

#### ***4.1.1. Immersion Ethnographic using Digital Environment in Daily Life***

Understanding domain context is an important factor in the progress of a project. It is because reducing missing parts of the overall project details. Therefore, it was tried to be exposed related information in the Classic Music Domain constantly for this project. Exposure in online and offline environment. Facebook and Instagram have exposed the social network platform, accounting for more than 50% of mobile digital product usage. A total of 82 Instagram followings, two hashtags, 29 Facebook-related joined groups, and 65 likes or following pages were intended to constantly expose domain context-related information when viewing SNS in everyday settings. When the researcher was working on a project to solve a problem in a new domain, it was necessary to familiarize itself with the domain. There is a difference between desk research and whether it was intended or natural. The process of exposure to the domain implies natural exposure, which utilizes the AI algorithmic recommendation system of

the social network. By frequently exposing intentional keywords in the first set, the context with content that is then naturally exposed can be established. There has been continuous exposure throughout the entire project. (See Figure 16). An advantage of seeing domain observations is that information about relevant contexts can be obtained extensively. The various contexts involved in the context also provide an opportunity to converge into slightly deeper contexts. An example is an information on the Anu Tali Talk Concert or a webinar about classical music.

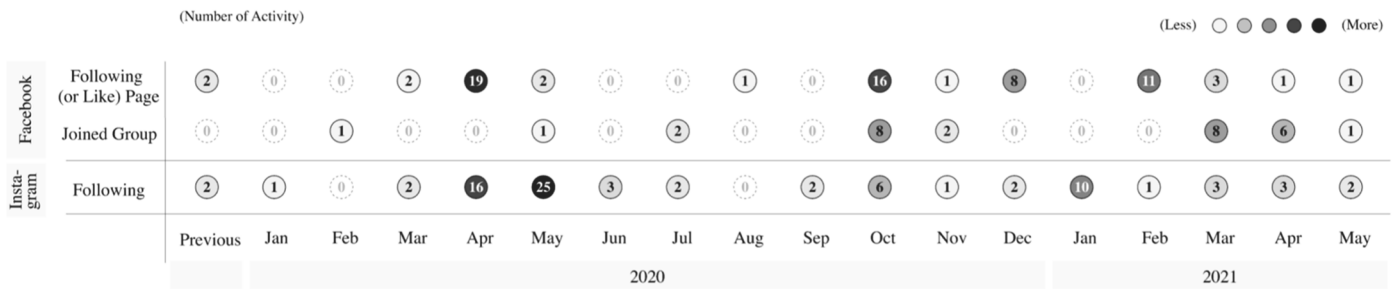


Figure 16. Immersion Ethnographic Using Facebook and Instagram

#### 4.1.2. Forwarded (Online or Offline) Observation about Domain Context

Digital channels were observed online in two significant categories: one-way information-providing channels and interactive community channels (KOCCA, 2019). The one-way information provision channel was investigated based on platforms according to video, text, and image. In the case of interactive community channels, an observation was conducted mainly on social network groups to understand the existing offline music collaboration process. In unilateral information, identified the overall classical music practice process or the basic behavioral characteristics shown to the observer. The potential issues or pain points in the practice process could be indirectly observed by the performers through the media voluntarily uploaded, such as the vlog. The vlog is an advanced version of a video diary or bulletin board, which is generally a video of a user's daily life. Information that can be observed through the existing shadowing method was acquired through these online channels. Online community channels observed how social media interacts with other musicians. This gave the performer information about what elements to pursue when receiving feedback from others while practicing. Besides, through real-time live performance feedback or related webinars, performers were able to observe the fundamental aspects of communication in the field of classical music. The data was collected online using the corresponding media for each piece of information. Furthermore, information was collected like this. The process of organizing information went through classifying, aligning, and organizing based on data.

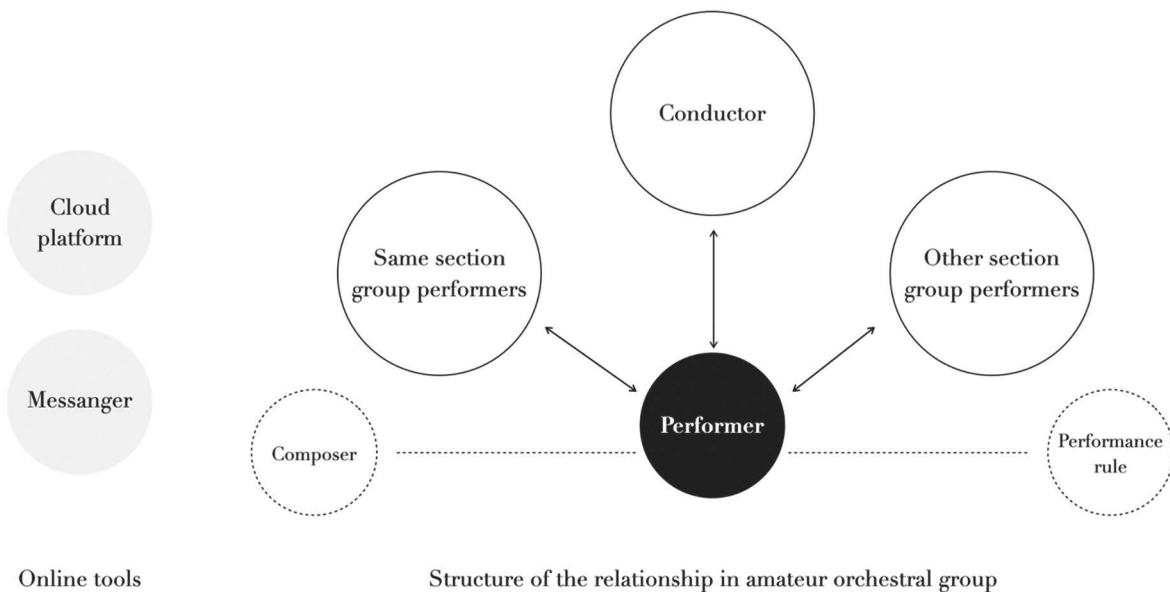
## 4.2. Pre-study Interviews

The interview was conducted with two interviewees for 40 minutes each. The interview questions were the overall music process, such as music collaboration, questions about the group section's role, difficulties in the ensemble, and how to communicate about music. Table 1 shows the interview detail concerning the instruments, propensity, work experience of the musician, and a group division. Interviews were conducted on two people. Interviewee AA is a female in an official orchestra of UNIST, UNISTRA, and AB is a male in an amateur orchestra club, ENSEMBLE.

**Table 1. Interviewee's Information**

	Instruments	Propensity	Work experience	Group
AA	Violin	Classic	5y	ENSEMBLE
AB	Piano & Cello	Classic & New Age	7-8y, 2y	UNISTRA

The results of the interview transcribed and then labeled with items that were each insight. It was derived the three key insights from the structure and communication or practice of an approximate group of amateur orchestras through interviews. Those are 1) *Archiving of the musical feedback*, 2) *Incompatibility of existing online tools for performance* and 3) *the importance about being aware of the ability of each performer*. The pre-interview transcript has labeled insights with line numbers of the sentences. This is to make it easier to understand when specific insight was discovered through the context near sentence later through the transcript.



**Figure 17. Structure of Amateur Orchestral Group**

Based on the results of pre-study interviews, it can summarize communication within the amateur orchestra groups. There are insights from here.

### ***Archiving of the Musical Feedback***

The sound is difficult to intuitively check feedback to a particular point and challenging to archive progress continuously in individual practice or ensemble. The feedback in progress during ensemble has been written as a text on the music score. These are difficult to identify a clear sound point of each feedback.

“I mark the part on the sheet music like 'concentrate conductor.’” (Participants AA, line number: 118)

“I usually write down the feedback from the entire ensemble practice in the music score, and I check it during the section practice.” (Participants AB, line number: 233)

### ***Incompatibility of Existing Online Tools for Performance***

Various platforms have been used sporadically for music collaboration or practice, such as messenger for announcements, team information, practice feedback as text, and Cloud platform for files of the music score or contents. This raises the need for an integrated management system suitable for the particular contexts of music.

“Usually, the Google Drive is used for files that are photo or music score sharing.” (Participants AA, line number:)

“We use Google Drive to share sheet music. But it's not accessible to the performers, and it's used for managing the executive member. They use Slack, and performers usually use ‘KakaoTalk’. There's a chat room for the announcement, and there's a separate chat room for each section. And we typically make in the short term for specific music for performance.” (Participants AB, line number: 244)

***The Importance about Being Aware the Ability of each Performer***

When performing in an amateur orchestra group, it is important to share each performer's status about practice and ability. Depending on this, the music is likely to be arranged in an easier or more challenging piece by group leader like conductor or concertmaster. The quality of the ensemble is improved by checking the individual's state within section. This is the minimum factor of settled the quality of the section or entire ensemble.

“I think the ensemble is similar to carving sounds. We have to keep trimming the popping sound for the harmonious sound.” (Participants AA, line number: 279)

“When practicing the entire ensemble, feedback is not called by individual's name, but by section. 'The cello to come in faster.' 'The cello is too big for this part.' we usually get feedback in sections.” (Participants AB, line number: 223&93)

### 4.3. Domain Exploration Outcomes

There are two parts in which a small group of music is formed: fixed units of a musician who is equally position level or a prominent musician is the main focus shown in the case of small music groups with fewer orchestra ten members. For more prominent orchestras of more than 20 people, the structure's verticality was shown in the order of conductor, section concertmaster, and performer. Based on these characteristics and the information of musicians with high digital literacy, a search target group, the structure of virtual characters, and music groups was also established. There are three outcomes of online observation and interview.

- *The characteristics of performers*
- *The classification model of the classical music interaction*
- *The 4 design categories with user stories*

#### 4.3.1. The Characteristics of Performers

By looking at the data, it is essential to understand that the persona provides a clear understanding of users through a detailed user model that describes key users (Cooper & Reimann, 2003). Persona makes it predictable how users will react to a particular function, situation, or environment. Based on the results of online observations, pre-study, and empathy map, Rapid Persona was consisted of. This was set up to ensure itself was not lost by setting up a virtual user in the project's progress (Ha, 2016). Rapid Persona's goals want the successful completion of the performance, effective communication with the other musician in the preparation process, and Inspiration through challenging experiences. The persona's frustration is difficult to organize and incorporate feedback from and from the group into practice. Several times when the rules set for ensemble performance are confusing. These are description of Persona 1 and 2:

Persona 1 is:

Bob is an undergraduate student who studied computer science at university and 25 years old. He made a new challenge as an amateur violinist. He often enjoys street busking for playing his music to people, and he also usually uploaded his video playing a violin. He loves classical music, but he likes to rearrange it in a new style or remix. He was in an amateur orchestra club at university.

Persona 2 is:

Jessy is a visual designer and 28 years old. Since she first learned cello in liberal arts class in college. She has been practicing step by step. After graduating from college and getting a job as designer, she applies to the amateur orchestra community as a hobby. She practices every Tuesday after work and prepares for the performance.

### ***4.3.2. The Classification Model of the Classical Music Interaction***

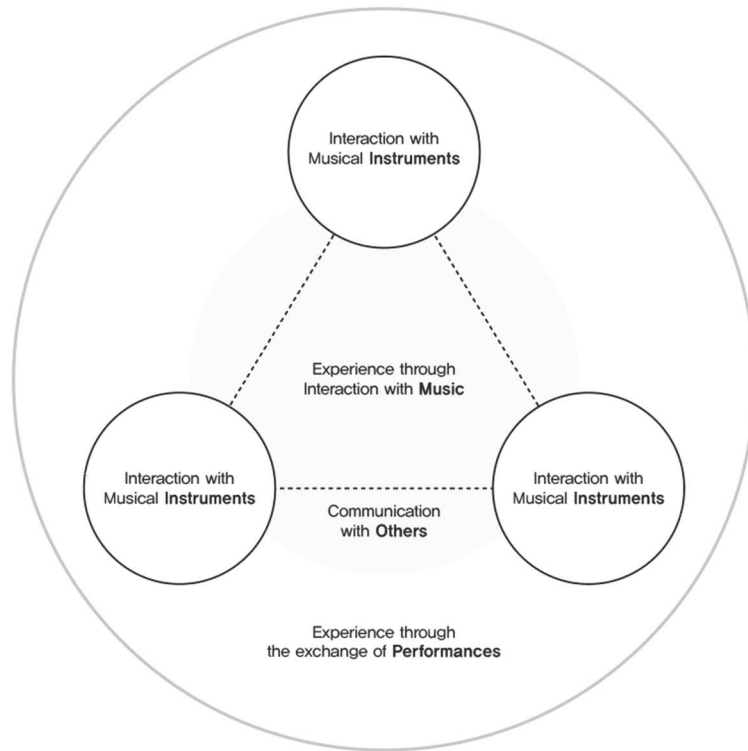
In music collaboration experience, it is defined as a total of four interactions based on musicians' interactions and information derived from research based on music experience model (Seo & Ryoo, 2014). Furthermore, four interactions can be categorized into two groups: interaction with Musical Instruments and Experience through Interaction with Music, interactions between musicians and musicians, and Experience through the exchange of Performance. Is divided. The system map was constructed based on the online data and interaction structure of the music experience (See Figure 18). There are four interaction elements that are Interaction with 1) *Musical Instruments*, 2) *Experience through Interaction with Music*, 3) *Communication with Others*, and 4) *Experience through the Exchange of Performance*.

*Interaction with Musical Instruments* is the experience of the performer's interaction with the instrument related to the instrument's characteristics, unlike performance, and can be an interaction felt through the instrument's use. There are instruments managing and tune sets. Typical examples are instrument management or turning. *Experience through Interaction with Music* is the individual's interaction with music, referred to the experience of the elements of the music itself. It provides users with relevant experiences through changes in music rhythm and melody. There is music score of various arrangements, already performed sound sources like other concerts, and contents about the music.

A typical example is the music library for reference. Collaboration in music collaborates with musicians who perform together and exchange media and various sources that musicians themselves are one music. Classical music is characterized by several arrangements from past composers to present musicians.

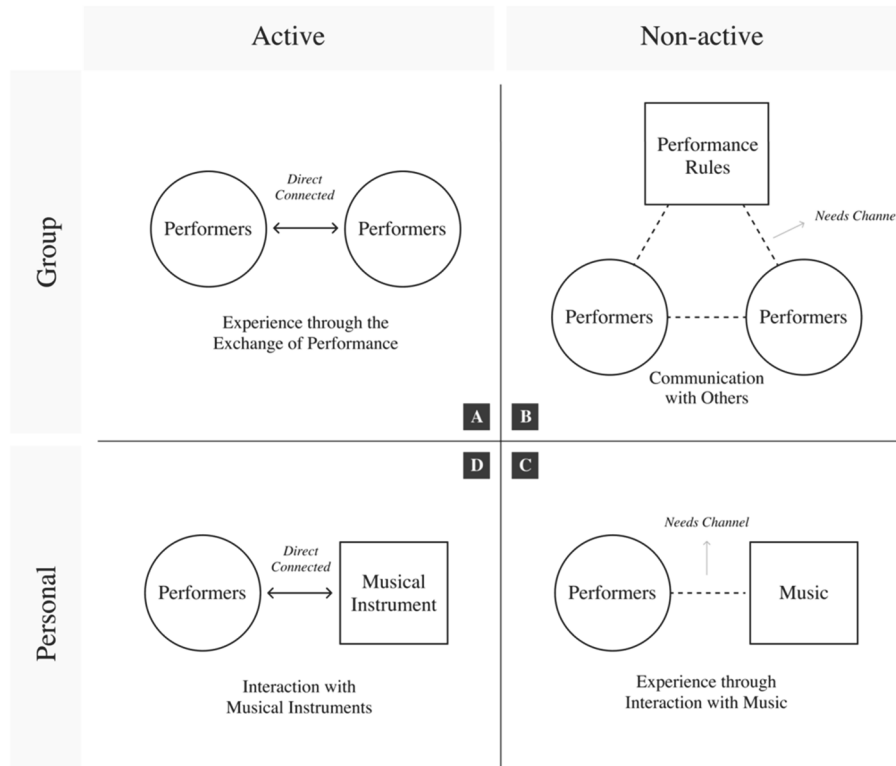
In this respect, the interaction with the music to the individual is also used as the main element. *Communication with Others* is the experience of playing simultaneously with the performers in the player's team, which creates a group relationship. Typical examples are community or stage rules. *Experience through the Exchange of Performance* is interaction through performance exchange being the interaction of non-verbal communication as an experience experienced by the performer immediately transforming and improvising melodies, rhythms, music, or music pieces through performance. There are sharing with other performers and feedback, meaning emotional and nonverbal experiences through mood. A typical example is sharing and feedback during performance.





**Figure 18. Interaction Structure of Music Context**

A modified classification model is conducted using the above four experience classifications (See Figure 19) with two newly defined classification factors: *Group and Personal* that elements conducted about relation with people whether situation of performing alone or together, and *Activity and Non-activity* that elements conducted with like directly playing using instruments or without instruments like reading music score.



**Figure 19. Classification Model of the Classical Music Interaction**

### 4.3.3. User Story

A user story identifies the user's needs of the user's story. The format of “the user story has three elements often articulated as Card, Conversation, and Confirmation” by Jeffries. The card for a user story is to define the intent that the user wants (See Figure 20 as an example).

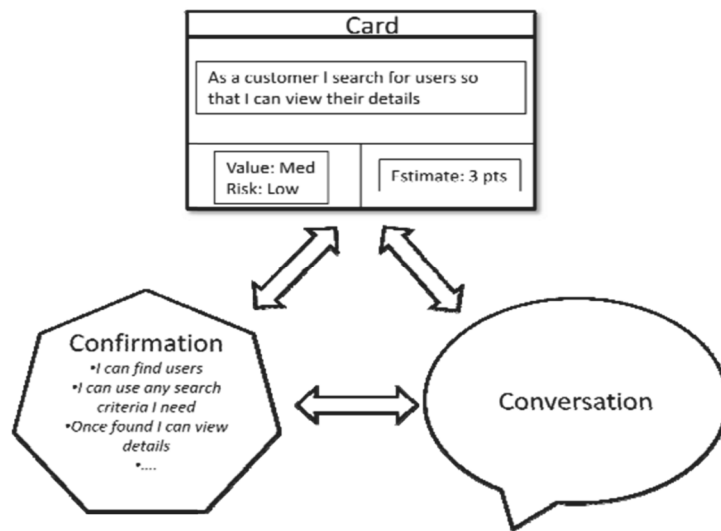


Figure 20. Elements of a User Story (O’Heocha & Conboy, 2010)

The user story method in card format was used to identify the users' benefit in this project. A format commonly used by agile terms takes the form for “As an <role> I want to <action> so that <result>.” The focus on increasing the functionality of short-term values to users is the lean design process (O’Heocha & Conboy, 2010). User stories were derived through Online Observation and were excavated based on online social networks. Based on the persona and interaction structure of the music context, the user story was written. Through research, there are findings that large individual interactions and interaction with musicians in musicians' interaction. Based on this, user stories were written according to personal, for the group. Sixteen and nine were derived, and a total of 25 were first defined, and then the priority.

**Table 2. User Stories for Personal**

No.	As a /an	I want to <function/goal/desire>		So that <benefit>
1	User	Management of musical instruments		Instrument in good condition
2	User	Check tuning		Tune in good condition
3		See the music sheet		Understanding the music well
4		Listen to the music	High quality sound	
5		Know the story of music	Basic information about music	
6			Musician information	
7			History	
8	User	Individual practice accompaniment		
9		Reveal the practice result		
10		Note personal practice diary	Specific practice goal	Self-motivation / Improving my ability to play music / Objective evaluation
11			Feedback myself	
12			Problem & Issues during practice	
13			Archive each practice (for comparing with last practice)	
14	User	Check feedback from group		
15	User	Practice simulation	Before / after practice	Understanding the music well / improving my ability to play music
16	User	Schedule check / notice about ensemble		Get information about ensemble

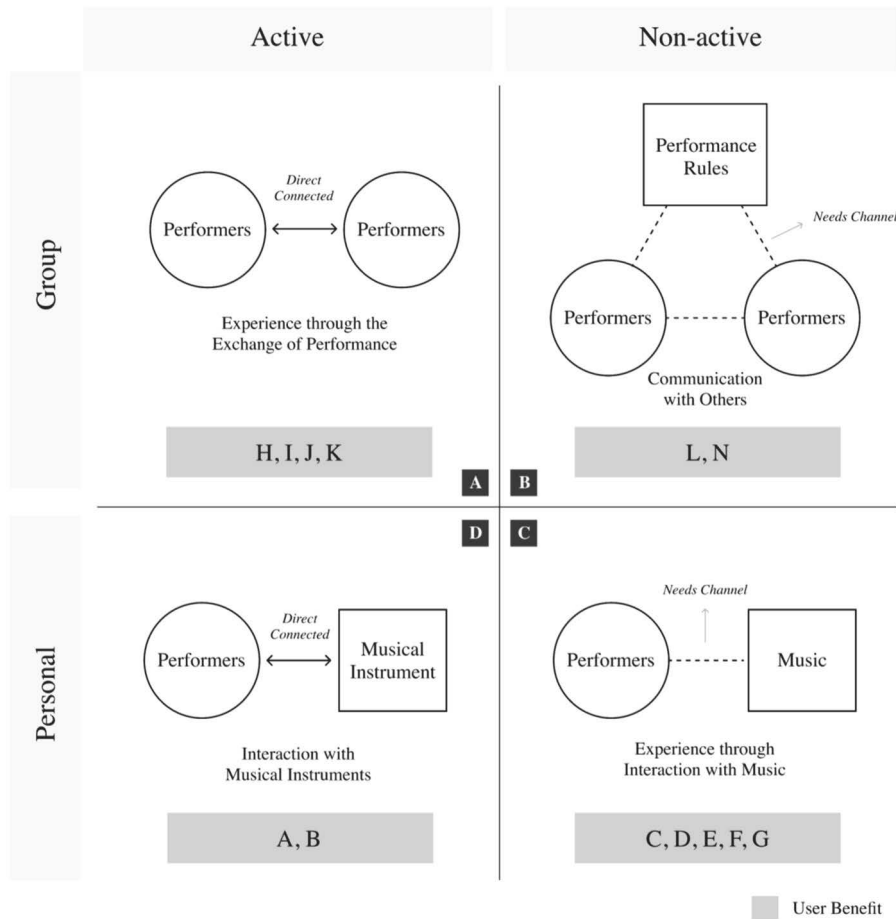
**Table 3. User Stories for Group**

No.	As a /an	I want to <function/goal/desire>		So that <benefit>
1	Users	Communicate about practice	Leader & Team, Team & Team, with Music	Increase efficiency for improving ensemble's quality / Well communication / Improving my ability to play music / Conflict reduction
2			Feedback sharing	
3			Sharing individual practice situation	
4			Stage rule	
5	Users	Group practice diary	Specific practice goal	Motivation / Improving my ability to play music / Objective evaluation
6			Feedback each other's	
7			Problem & Issues	
8			Archive each practice (for compared last practice)	
9	Users	Information	Stage rule (Cue, Encore Music, Cloth)	Well communication

**Table 4. User Benefit**

Code	User Benefit
A	Maintaining of the best condition of Instrument
B	Tune of the instrument
C	Understanding the Historical Context of Music
D	Self-Motivation about Practice
E	Subjective practice assessment through self-awareness
F	Improving one's ability to play music
G	Information about the group
H	Efficiency for improving quality of ensemble
I	Communication with other performers
J	Improving the ensemble's ability to play music
K	Reducing conflicts in coordinating opinions
L	Subjective practice assessment from other performers
N	Group-Motivation for a successful performance

User benefits that are common in user stories are derived and categorized. From the user stories, user benefits were derived into the classification model (See Figure 19), based on the type of user stories. The main user benefit was mapped with the Interaction structure of the music context. Four user story sentences are defined with the converged organized outcome. Interaction structure of music context is matched with code from user benefit (See Table 4). Based on these, the user story was defined.



**Figure 21. Mapping User Benefit and Classification Model**

#### ***4.3.4. Design Categories***

The final summary of user story is expressed in sentences based on a matched user story-based user benefit and Interaction structure of music context. The four main design categories with user stories that are 1) *Group Ensemble Diary*, 2) *Personal Practice Diary*, 3) *Musical Communication*, and 4) *Personal Practice Result*.

##### ***Group Ensemble Diary***

“I want to record the overall situation of our team through my diary and use this recording effectively to improve the quality of our performance!”

##### ***Personal Practice Diary***

“I wonder if I am doing well now, and I want to increase the efficiency of my practice by recognizing my position rather than blindly working hard.”

An orchestra, a collection of individual characteristics that make up an ensemble, can produce musical results of a completely different atmosphere depending on individual characteristics. That is why individual competence or propensity is important. From this, it can drive to successful results with the group.

##### ***Musical Communication***

“I hope the quality of the whole ensemble will be higher by having the effect of practicing together, even when practicing alone!”

##### ***Personal Practice Result***

“It's boring to practice alone. I don't have a lot of motivation either, but for motivation, I want to let you know about my practice!”

## 5. DESIGN DEFINITION

This chapter discusses the definition about detail feature ideation. For this, firstly the co-design workshop was conducted for spreading ideas. After co-design workshop, it was listed the ideas drawn, defined the main features through categorizing, and then created a wireframe. In this process, features that may be digitally transformed into online platforms were selected for the purpose of ideas for more detailed functional definitions.

### 5.1. Co-design Workshop for Ideation

Based on the four categories that are 1) *Personal practice diary*, 2) *Personal practice result*, 3) *Music communications*, and 4) *Group ensemble diary* with user stories derived from Chapter 4, a co-design workshop was conducted to derive ideas. The co-design workshop was conducted with eight students in the design major field. The workshop was conducted by producing an ideation sheet to derive keywords and ideas for the main features according to each category. Participants each scanned the results and received them in pdf format.

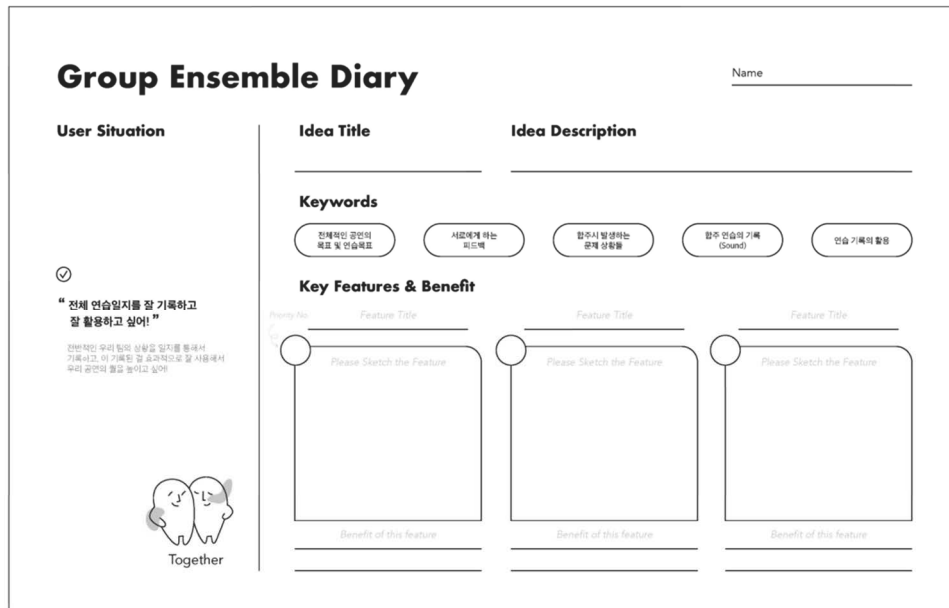
The eight participants (2 female: HG, JH and 6 males: JS, JW, KJ, KB, LM, PY) in the design major who participated in the co-creation workshop conducted an ideation session after fully understanding the virtual persona and user stories and needs derived for the ideation. Besides, to help understand the user's story, it had showed them examples of famous entertainment programs. Based on the ideation results, the functions derived according to the four user stories were organized. That was why it was necessary to proceed with a presentation explaining the relevant background because it could be an unfamiliar context to participants. In the process, a few scenes from famous entertainment programs were used to describe design categories that correspond to user needs.



### 5.1.1. Co-creation Workshop Results

#### Group Ensemble Diary

For the ideation of *Group Ensemble Diary* category, five keywords are presented for the worksheet. There are 1) *Performance Goal*, 2) *Feedback with other Performers*, 3) *Problem Situation during Ensemble*, 4) *Recording sound during Ensemble*, and 5) *Using the Practice Recording*.



The ideation sheet is titled "Group Ensemble Diary" and includes a "Name" field. It is divided into several sections:

- User Situation:** Contains a checkmark icon and the text: "전체 연습일지를 잘 기록하고 잘 활용하고 싶어!" (I want to record and use the entire practice diary well!). Below this is a small illustration of two figures and the word "Together".
- Idea Title:** A blank line for writing the title.
- Idea Description:** A blank line for writing the description.
- Keywords:** Five rounded rectangular boxes containing the following keywords: "전체적인 공연의 목표 및 연습목표" (Overall performance goals and practice goals), "서로에게 하는 피드백" (Feedback given to each other), "합주시 발생하는 문제 상황들" (Problems that occur during ensemble), "합주 연습의 기록 (Sound)" (Recording of ensemble practice (Sound)), and "연습 기록의 활용" (Use of practice records).
- Key Features & Benefit:** Three columns for sketching features. Each column has a "Priority No." field, a "Feature Title" field, a "Please Sketch the Feature" box, and a "Benefit of this feature" field.

Figure 22. Ideation Sheet for Group Ensemble Diary

**Table 5. Ideation Result of Group Ensemble Diary**

Keywords	Description Summary	Source Code
Setting Performance	Setting the performance goal of leader	LMA03
Goal of Leader / Setting Section Goal	Checking the achievement of section goal	KJA01
Checklist of Performance Rules	Checking the rule in real-time	JSA02, JSA03
	Checklist of the rule for ensemble	JSA01
	Performance Calendar	JHA01
	Sharing the diary about text, sound, and visual information	JWA01
Feedback each section / Providing Information	Providing extra information about the section	LMA01
	Providing visual feedback about wrong part based on music score	HGA03
	Uploading practice recording according to each instrument	HGA02
	Sharing the practice diary that connected with group diary	LMA02
	Feedback each section	KJA02
Practice Diary Easy to Use	Group diary like daily diary	JWA02
	Guide for checking rule	KBA02
	Giving support contents for recording music diary	KBA01, PYA01
Comparing Practice Recording and Problem Solving	Comparing the practice with past	HGA01, PYA03
	Recording practice condition	JHA02
	Recording the solution about problem situation	PYA02

### Personal Practice Diary

For the ideation of *Personal Practice Diary* category, five keywords are presented for the worksheet. There are 1) *Set goals and check achievement*, 2) *Self-feedback*, 3) *Issues during practice*, 4) *My practice diary*, and 5) *Use of practice diary*.

## Personal Practice Diary

Name \_\_\_\_\_


User Situation	Idea Title	Idea Description												
<p>☑</p> <p><b>“ 지금 잘하고 있나? 의문이 들어! ”</b></p> <p><small>연습 일지에 연습 중 잘 안되는부분, 나의 연습 목표, 연습과정 기록(Sound)과 같은 연습 중 이슈들을 기록 하고 싶어!</small></p>	<p><b>Keywords</b></p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid gray; border-radius: 10px; padding: 2px 5px; font-size: 8px;">연습 목표 설정 및 목표 달성 체크</div> <div style="border: 1px solid gray; border-radius: 10px; padding: 2px 5px; font-size: 8px;">스스로에게 하는 연습 피드백</div> <div style="border: 1px solid gray; border-radius: 10px; padding: 2px 5px; font-size: 8px;">연습 중 문제점 이슈 (- 무엇이 잘 안했어?)</div> <div style="border: 1px solid gray; border-radius: 10px; padding: 2px 5px; font-size: 8px;">나의 연습 기록 (Sound)</div> <div style="border: 1px solid gray; border-radius: 10px; padding: 2px 5px; font-size: 8px;">연습 기록의 활용</div> </div>	<p><b>Key Features &amp; Benefit</b> (위의 키워드를 기반으로 피쳐를 그려주세요!)</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">Priority No.</th> <th style="width: 33%;">Feature Title</th> <th style="width: 33%;">Feature Title</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">Please Sketch the Feature</td> <td style="text-align: center;">Please Sketch the Feature</td> </tr> <tr> <td style="text-align: center;">2</td> <td style="text-align: center;">Please Sketch the Feature</td> <td style="text-align: center;">Please Sketch the Feature</td> </tr> <tr> <td style="text-align: center;">3</td> <td style="text-align: center;">Please Sketch the Feature</td> <td style="text-align: center;">Please Sketch the Feature</td> </tr> </tbody> </table>	Priority No.	Feature Title	Feature Title	1	Please Sketch the Feature	Please Sketch the Feature	2	Please Sketch the Feature	Please Sketch the Feature	3	Please Sketch the Feature	Please Sketch the Feature
Priority No.	Feature Title	Feature Title												
1	Please Sketch the Feature	Please Sketch the Feature												
2	Please Sketch the Feature	Please Sketch the Feature												
3	Please Sketch the Feature	Please Sketch the Feature												
<p>☑</p> <p><b>“ 연습일지를 어떻게 보면 더 도움이 될까? ”</b></p> <p><small>연습들을 기록을 했는데, 어떻게 하면 이 기록들을 효과적으로 잘 활용 할 수 있을까?</small></p> <div style="text-align: center;">  <p>Alone</p> </div>	<p><b>Benefit of this feature</b></p> <p>_____</p>	<p><b>Benefit of this feature</b></p> <p>_____</p>												

Figure 23. Ideation Sheet for Personal Practice Diary

**Table 6. Ideation Result of Personal Practice Diary**


Keywords	Description Summary	Source Code
Set Goals and Check	Setting and achieving goals using role models	PYB01
Achievement (3)	Intuitive visualization of goal achievement	KJB01, KJB02
Goal setting process / Intuitive visualization of goal attainment		
Self-feedback (3)	Self-assessment and evidence creation	PYB02
/ Issues during	Self-analysis of problems with specific marking	LMB02
Practice (2)	Self-feedback using comments	HGB02
Objective feedback at specific points / Subjective feedback		
My Practice Diary (5)	Automation of recording	JHB01
	Objective recording of practice time	JSB01, JSB02
	Exercise History Timeline	KBB02
	Visualization of past exercises	HGB01
	Practice diary combined writing, sound, and visual information.	JWB01
Convenience of recording / Visualization of information / Recording way organized in time		
Use of Practice Diary (4)s	Compared to self in the past, compared to others	JSB02, KBB01
	Automatically provide feedback	HGB02, HGB03
	Practice recording using community	LMB01
	Utilization of practice records through sharing in SNS	JWB02
History-based comparative analysis / Checkable at any time / Shared with group members.		

**Musical Communication**

For the ideation of *Musical Communication* category, three keywords are presented for worksheet. There are 1) *Communication with the leader and performers*, 2) *Communication between performers* and 3) *Sharing feedback about practice*. According to these keywords, the participants completed their work sheet for ideation.

## Online Music Communication

Name \_\_\_\_\_

User Situation	Idea Title	Idea Description
<p>☑</p> <p>“떨어져서 연습해도 같이 연습하는 것처럼 소통하고 싶어!”</p> <p><small>혼자 연습 할 때도 같이 연습하는 것 같은 느낌을 내서 언제 어디서든 같이 할 수 있으면 좋겠어!</small></p> <div style="text-align: center;">  <p>Together</p> </div>	<p><b>Key Features &amp; Benefit</b></p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>[ “리더와 팀원간의 소통!” ]</p> <p><small>Feature Title</small></p> <div style="border: 1px solid gray; border-radius: 10px; padding: 5px; width: 100px; height: 100px; margin: 5px auto;"> <p style="text-align: center; font-size: small;">Please Sketch the Feature</p> </div> <p style="text-align: center; font-size: x-small;">Benefit of this feature</p> </div> <div style="text-align: center;"> <p>[ “개인과 팀원들과의 소통!” ]</p> <p><small>Feature Title</small></p> <div style="border: 1px solid gray; border-radius: 10px; padding: 5px; width: 100px; height: 100px; margin: 5px auto;"> <p style="text-align: center; font-size: small;">Please Sketch the Feature</p> </div> <p style="text-align: center; font-size: x-small;">Benefit of this feature</p> </div> <div style="text-align: center;"> <p>[ “연주에 대한 피드백 공유” ]</p> <p><small>Feature Title</small></p> <div style="border: 1px solid gray; border-radius: 10px; padding: 5px; width: 100px; height: 100px; margin: 5px auto;"> <p style="text-align: center; font-size: small;">Please Sketch the Feature</p> </div> <p style="text-align: center; font-size: x-small;">Benefit of this feature</p> </div> </div>	<hr style="border: 0.5px solid black;"/>

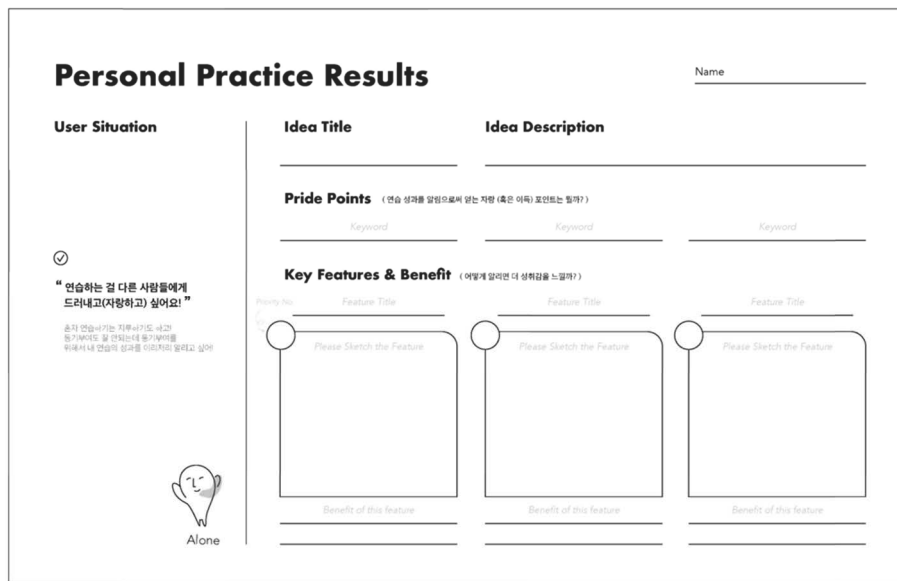
**Figure 24. Ideation Sheet for Musical Communication in Group**

**Table 7. Ideation Result of Musical Communication in Group**

<b>Keywords</b>	<b>Description Summary</b>	<b>Source Code</b>
Communication with the leader and performers	Checking team members' performances and reactions.	HGC01
	Sharing face, sound, and atmosphere in real-time	JWC01
	Managing and checking by position	JHC01
	Providing separate communication channels by role	LMC01
	Announcement of clear goals	PYC01
	Leader-focused online channel approach	KBC01
Communication between performers	Review each exercise music (feedback)	HGC02
	Real-time sharing of exercise-related comments	JWC02
	Ensemble through video sharing, not real-time.	KJC02
	Separated for each ensemble section	LMC02
	Splitting recording / ensemble recording	PYC02
Sharing feedback about practice	Real-time feedback that makes it easy to respond to	HGC03
	Partial comments using music score	JHC03, LMC03
	Chatting about ensemble	KJC03
	Marking positive and negative feedback separately	KBC03
	Update feedback information, such as good points and improvements, by period	PYC03

**Personal Practice Result**

For the ideation of Personal Practice Result category, there was not presented keywords and required participants to write them down. The keywords that written from participants were *Using competitive psychology*, *Visualization of practice time*, *Creating sound source of practice results*, *Exposure feedback to audience or professionals' musicians*, and *Representing different ways like visualization*. The derived pride points are self-PR (3), growth and development (2), self-satisfaction (4), goal achievement (2), feedback (2), and continuous motivation (1).



The form is titled "Personal Practice Results" and includes a "Name" field. It is divided into several sections:

- User Situation:** Contains a quote: "연습하는 걸 다른 사람들에게 드러내고( 자랑하고) 싶어요!" and a small illustration of a person labeled "Alone".
- Idea Title:** A blank line for writing the idea's title.
- Idea Description:** A large blank area for describing the idea.
- Pride Points:** A section with the prompt "(연습 성과를 알림으로써 얻는 자랑 (혹은 이익) 표현하는 일까?)". It includes three "Keyword" labels and lines for input.
- Key Features & Benefit:** A section with the prompt "(어떻게 알리면 더 성취감을 느낄까?)". It contains three columns, each with a "Priority No.", "Feature Title", a "Please Sketch the Feature" box, and a "Benefit of this feature" line.

**Figure 25. Ideation Sheet for Personal Practice Results**

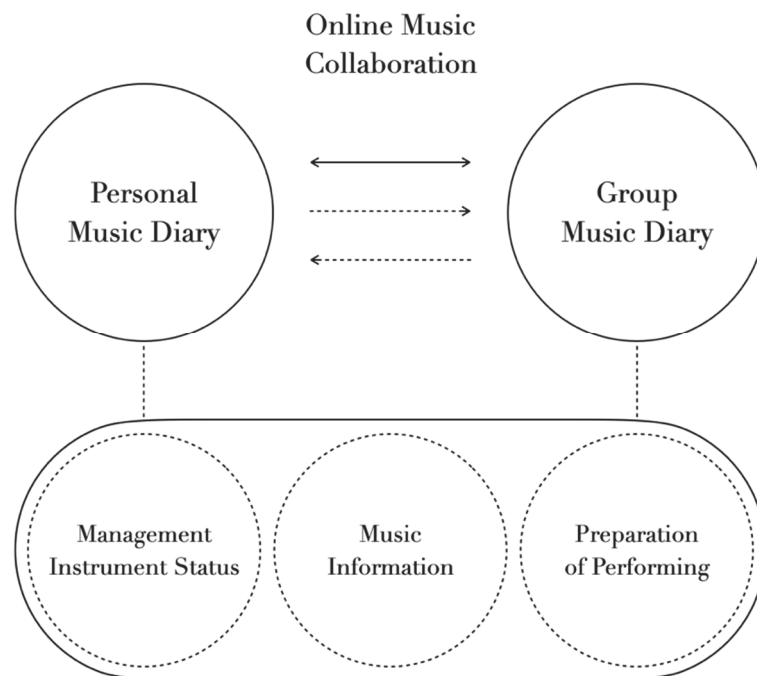
**Table 8. Ideation Result of Personal Practice Results**

<b>Description Summary</b>	<b>Source Code</b>
Performance challenge feature	KJD01
Stimulating competitive psychology through ranking	HGD02
Exposing songs from the top of the competition rankings	HGD03
Ranking through practice time	JHD03
Self-engagement using Like	LMD01
Classification based on practice growth	LMD03
Decorating practice video	PYD01, LMD02
Recording successful experiences	HGD01, PYD02
Record and about growing progress and show it off	KJD03
Using competitive psychology / Visualization of practice time / Creating sound source of practice results	
Use recorded exercise records externally (commercially) and then feedback to the public	JHD01
Anonymous feedback to see responses from a new perspective	KBD01, JSD03
Share with performers playing the same music	JWD02
Evaluate through SNS and gain continuous motivation	JWD01, KJD02
Share with the community of performers.	JSD02, JHD02
Visualize the history of good performance and share content	JSD01
Exposure feedback to audience or professionals' musicians / Representing different ways like visualization	



***Categorizing of the Co-design Workshop Results***

Based on the results of the ideation, the categories were mapped among keywords, and the results were derived as follows (See Figure 26 and Table 9). In the idea sheet of the first user story, five keywords were presented as examples: setting practice goals and checking goal attainment, feedback on practice to oneself, problem issues during practice, and utilization of practice records. The detailed ideas based on this were categorized and remapped as keywords. The idea sheet for the second user story was made to write about the design points and feature configuration in improving the exercise resulting from exposure to individual practice results. The derived pride points are *self-PR*, *growth and development*, *self-satisfaction*, *goal achievement*, *feedback*, and *continuous motivation*. Keywords derived by categorizing these pride points and their detailed ideas include competitive psychological use, visualization of practice time, records of exercise results, feedback from other experts, and records in other ways than sound. There are real-time communication and communication through storage in online music communication and identity sheet based on the user storis. Furthermore, there is a visual comparison of target setting, group rule check, feedback according to each part, and information and exercise records in the last fourth user story, the group ensemble diary. As a result of connecting the results analyzed by the user story to another point of connection, features were formed from online music collaboration, management instrument status, music information, and play preparation.



**Figure 26. Categorizing of the Co-design Workshop Result with Features Information**

**Table 9. Categorizing of the Co-design Workshop Results**

<b>Online Music Collaboration</b>			
<b>Real-time sharing ensemble</b>	<b>Real-time communication</b>	<b>Non-real time-sharing ensemble</b>	<b>Comments by music score</b>
Real-time face	Access channels that are accessible	Ensemble of different time	Partial comment
Sound	Check by position	Split recording	Periodic comments
Mood sharing		Ensemble recording	
Real-time ensemble			
<b>Group Music Diary</b>			
<b>Goal</b>	<b>Feedback</b>	<b>Ensemble rule</b>	<b>Use of records</b>
Describe the objectives of the performance	Position specific feedback	Provide the rules of the performance	Analysis through comparison with past exercises
Describe the objectives of each position	Information provided		Coping with problems
Mark achievement	Positive and negative feedback separated		
<b>Exposure</b>			
Exposure to professionals (team members)			
Exposure to prospective audiences			
<b>Personal Music Diary</b>			
<b>Goal</b>	<b>Feedback</b>	<b>Guide to record</b>	<b>Expression of records</b>
Set personal goals	Objective feedback	Increase exercise log competition rate through alarm or guide	Exercise records
Mark achievement	Subjective feedback		Visualizations of exercise levels
Provide rewards based on achievement			Sounds and visual representations together

## 5.2. Design Concept Features

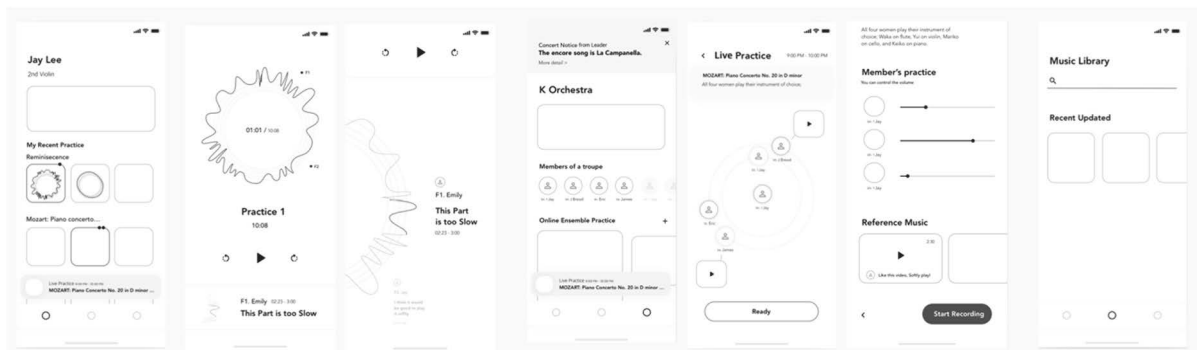
### 5.2.1. Main Features for Concept Design

Based on the concept system model and two interviews, the key screen's wireframe is created from the main features and then inserted and visualized the content to help understand the concept during the concept validation (See Figure 27). The main features are presented as the function of music being recorded and recorded in personal music diaries, the information provided for ensembles in group music diaries, the part about live/non-live practices, and the music library about music can be easily obtained (See Table 10).

**Table 10. Main Features**

Personal Music Diary	Group Music Diary	Music Library
Bookmark & Self Feedback	Group Information	Music Score
Practice Archive	Live Collaboration	Video / Album
	Non-live Collaboration	Text Contents
	Bookmark Group Feedback	
	Practice Archive	

*Group Music Diary* is the entire performance information, musical instrument positions, and overall practice schedules, information about each performer, and things like rehearsal music and rules are announced. Live Practice is what users can play and give feedback in real-time at the same time without any space constraints. Non-Live Practice is what users can practice the song by putting it on other performers' records files without any restrictions on space and time. *Personal Music Diary* provides individual practice information, feedback from others, and practice diary data visually. *Music Library* provides information about the music, score, and performance videos



**Figure 27. Wireframe Screens Based on Main Features**

### 5.3. Opportunities for Digital Transformation

An opportunity factor can be derived to propose a new style of experience in digital transformation. Based on the results obtained earlier, it was defined an opportunity factor to be mindful of in the digital transition. Through the defined Design features, there are four elements of opportunity for the digital transformation of amateur musicians' collaboration:

#### ***Connection of Experience between Personal Practice and Collaboration***

In which individuals come together as orchestra, music collaboration is important for personal competence and successfully achieves the group's common goal. Most personal issues occur a lot when people are alone, and feedback from the group is also highly volatile and can be easily missed. This is why there is a digital transformation opportunity using digital service to make it easy to connect in non-face-to-face.

#### ***Virtual Collaboration for Amateur Classical Musicians***

*Live Collaboration* and *Non-live Collaboration* features can potentially allow virtual collaboration online access to the surroundings through the online platform. This has a possibility to overcome the limitations of place, time.

#### ***Digital Archiving for each Progress***

Through the *Music Diary*, it can have the advantage of archiving information about feedback data during performing that has been quickly disappeared as voice, passing feedback digitally, and accumulating information. Digital archives should focus on how to utilize them, not just archive something. The possibility of digital archives in this field is that they can expect high utilization in collaboration by managing information that is handwritten and easily missed.

#### ***Integrated Information Library for Practicing***

The music that the performer will play is made in the past. Performing music is about acquiring and interpreting music. That is why it is important to identify and acquire the existing sources of many musicians who interpreted it in various ways, starting with the composer who made it. It has acquired various musical sources, such as text, images, sound, and video. Musicians had to go through several online channels. There is a possibility of integrating this necessary information through a digital library using *Music Library* feature.

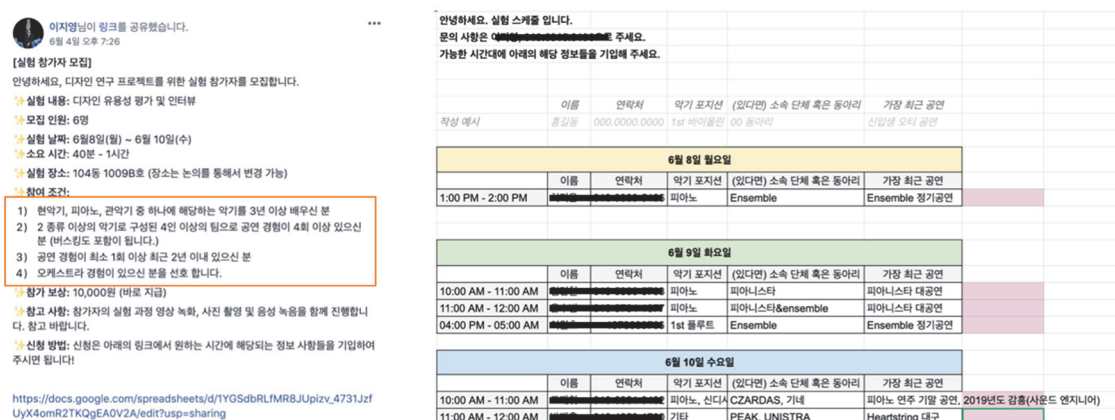
## 6. CONCEPT DEVELOPMENT

After spreading ideas through verifying the usefulness of the main functions based on the previously written key screen, it was carried out to use them to remove or add detailed functions to the main functions. Insight was derived through user studies in the Interview and Concept Validation. After investigating the features of other competitive services based on key features, a verification interview is conducted to evaluate key screen main functions. The user survey results were embodied in the main features and detailed features using the Ground theory technique.

### 6.1. In-depth Interview for Concept Validation (1<sup>st</sup> Iteration)

To verify the main derived functions, the verification and the iteration process were carried out. A verification assessment was conducted on seven participants. It was divided into interviews and verification evaluations of key features. In the case of interviews, there were four categories: basic information, personal practice process, group practice process, and performance experience. The participants under follow these criteria:

- People who have learned one more instrument, piano, string, wind instruments, etc. for more than three years.
- People who belonged to a team of 4 or more players consisting of 2 or more types of instruments, who have more than four performances (including busking)
- People who have at least one performance experience in the last two years
- People with more than ten orchestra experiences.



The figure shows a recruitment email on the left and a spreadsheet of participants on the right. The email includes details about the recruitment process, such as the number of participants (6), the dates (June 8-10), and the location (104th and 109th Bldg). It also lists the criteria for participants, which are the same as those listed in the text above. The spreadsheet lists the names, instruments, and performance experiences of the seven participants.

이름	연락처	악기 포지션 (있다면) 소속 단체 혹은 동아리	가장 최근 공연
홍길동	000.0000.0000	1st 바이올린 00 동아리	신입생 오피 공연
6월 8일 월요일			
이름	연락처	악기 포지션 (있다면) 소속 단체 혹은 동아리	가장 최근 공연
1:00 PM - 2:00 PM		피아노	Ensemble
			Ensemble 정기공연
6월 9일 화요일			
이름	연락처	악기 포지션 (있다면) 소속 단체 혹은 동아리	가장 최근 공연
10:00 AM - 11:00 AM		피아노	피아니스타
11:00 AM - 12:00 AM		피아노	피아니스타&ensemble
04:00 PM - 05:00 AM		1st 플루트	Ensemble
			Ensemble 정기공연
6월 10일 수요일			
이름	연락처	악기 포지션 (있다면) 소속 단체 혹은 동아리	가장 최근 공연
10:00 AM - 11:00 AM		피아노, 신디시	CZARDAS, 기네
11:00 AM - 12:00 AM		기타	PEAK, UNISTRA
			Heartstring 대구

Figure 28. Recruiting of Participants

Interviewee CA is a profession cellist, and CB, CD, CE, CG, CG, and CH are in an amateur music club. ENSEMBLE and UNISTRA is orchestra group in UNIST. PIANISTAR, PEAK, and CZSRDAS is music club, but usually have an ensemble performance.

**Table 11. Participants Information**

	<b>Instruments</b>	<b>Propensity</b>	<b>Work experience</b>	<b>Group</b>
CA	Cello	Classic	Over 20y	UNIST (TA)
CB	Piano & Violin	Classic	6y, 2y	ENSEMBLE
CD	Piano & Flute	All	6y, 1y	PIANISTAR
CE	Piano	Classic (Leading)	20y	PIANISTAR, ENSEMBLE
CF	Flute & Conduct	Classic (Leading)	10y, 2y	ENSEMBLE
CG	Guitar	Classic & Digital Music	7y	PEAK, UNISTRA
CH	Synthesizer	Digital Music	8y, Mixing	CZSRDAS

The interview lasted for 20 minutes, and the purpose was to identify the missing user needs other than the key features and make detailed design modifications. The Interview lasted 20 minutes and 30 minutes for Concept validation. The Interview questions are composed of four categories that are basic participant's music experience information, personal practice process, their group practice process, and performance experience. There are semi-structured interviews involved (See Table 12).

**Table 12. Interview Structure**

<b>Basic Information Survey</b>
Musical career
Affiliated organizations and features
Position
Stage experience
<b>Personal Practice Process</b>
Practice in preparation per day
Usual daily practice
Practicing on music (external to the instrument) / Music Communication
Important factors in improving one's skills in personal practice
Related to Practice Habits
<b>Group Practice Process</b>
Improvement points in the preparation of the performance
Internal group collaboration
Progress of the Group practice
Differences between individual practice and group practice
Important factors for a successful performance concert in a group
<b>Performance experience</b>
Important factors in the experience in aspect of leading a performance



**Figure 29. Participant Activities during the Concept Validation Stage**

It was aimed at verifying based on key screens on whether to achieve the overall purpose of improving individuals' and groups' performance and facilitating the effective non-offline ensemble communication process. The verification interview process was conducted by first presenting a functional description of the key feature through a paper ranch, then asking each feature's concept about Plus, Minus, Interests, and additional Idea. The Ideation process was carried out so that participants talked, and the organizer designer received and entered. Post-it were used in the process, and in some cases, validation interviews were conducted for each function through talk (See Figure 29).

### 6.1.1. Concept Validation Results



**Figure 30. Result of Interviewee Ideation**

Presentations of basic ideas were written on post-it during the interview through the Affinity Diagram and matched for each feature. The main insight is using music score for musical feedback and communication is important. There are three-point of the result in-depth interview under follows:

- *Feedback according to each feature and drop few features*
- *New features define based on emerging needs and insights*
- *Define the structure of the detailed practice process*



**Table 13. Reflection of Main Features**

<b>Personal Music Diary</b>	<b>Group Music Diary</b>	<b>Music Library</b>	<b>Digital Music Score</b>
Practice Archive for Sharing	Group Information Live Collaboration Non-live Collaboration Group Feedback Practice Archive	Music Score Video / Album Text Contents	Connected Personal and Group Music Diary

The idea of archiving visualization of individual sound records was dropped through a concept validation interview. The main opinion was that even if each element was meaningful, it would not be necessary if it was not intuitive, and the recording of the sound was enough for individual recording and sharing. From this perspective, this project needed to re-access the individuals' focus point to collaboration aspects. Through the interview, the users have a special meaning about music score. They sometimes used a few colored pens for noting the music score. Music score was used elements primarily as personal recording aspects and as communication tools with other performers.

## 6.2. Auto-ethnography for Detail Design (2<sup>nd</sup> Iteration)

### 6.2.1. Auto-ethnography

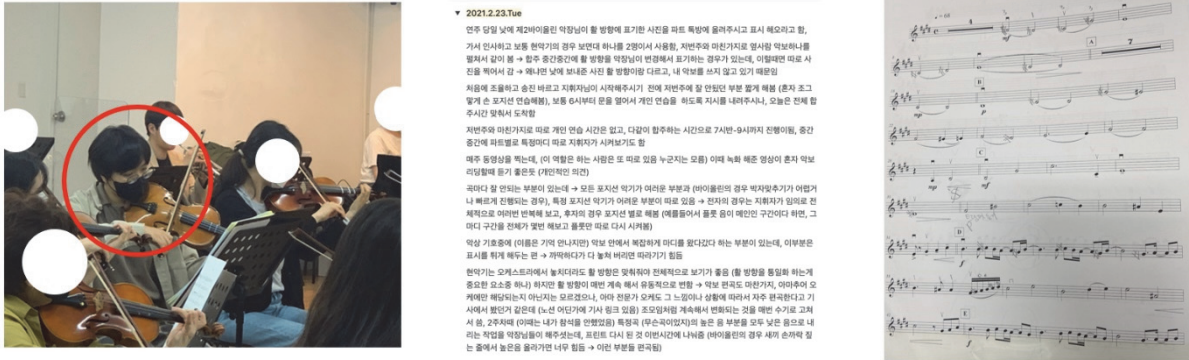


Figure 31. 2nd Violin Section (Left), Diary Study (Middle) and Feedback on the Music Score (Right)

After completing the verification of main features, continuous participation observation was carried out from February to April 2021 for a detailed function definition of each screen design. If the overall conceptual and main features were verified through the previous in-depth interview for concept validation, the next step was to conduct the auto-ethnography for detailed design based on the results of the first verification interview. The role of the auto-ethnography was a violinist in the string section in an amateur orchestra organization located in Ulsan for three months. The basic environment for this orchestra was consisted of various type of channels. There were online channel and the offline practice space for music-making process with together.

For the group communication after or before the offline practice, we used the online communication tool KakaoTalk to announce the place, time, music information, and chat, and BAND about sharing music score, reference contents, photo, and video filming during the practice process. Chat rooms of KakaoTalk were divided according to purpose, one was for the entire announcement for all performers, and the other was for detailed communication by section. Similarly purposed with the already suggested structure of the orchestra (See Figure 17), this group also used online tools for basic communication and sharing files. The practice space for playing an instrument together was large enough to cover all performers. The instrumental sections for practicing were following the orchestra seating arrangement with the conductor at the center (See Figure 6). The practice diary that was recorded the experience and feelings during practice were collected as primary data. In addition, notes of the music score were collected as images in each activity session.

### ***6.2.2. Transmission of Musical Interpretation from Conductor***

When the ensemble is conducted with new music, it sets the overall tone of the music by the conductor and then goes into detailed practice by each section (EA01, EB03). Section concertmaster conducted about detailed technical approach, such as the direction of the bow in section (EC03). There are three insights of feedback based on musical interpretation delivered during the ensemble practice of the conductor, which creates the overall tone and shape of the music. There are 1) *Contextual Information of Music*, 2) *Unity of Technical Approach*, and 3) *Metaphorical Interpretation by Conductor*.

#### ***Contextual Information of Music***

Through additional explanations about musical context such as “It’s a song, so play it as if you’re singing” (ED02). or “Make it feel as if the ship is anchored as in the movie” (ED08). rather than a difficult musical symbol, it makes it easier to understand and remember the overall tone of the music.

#### ***Unity of Technical Approach***

Even with musical symbols of the same music score, the unity of the technical approach of music is particularly important visually. It is important to start and end with the same atmosphere as the common gestures of the beginning and the end of the ensemble. Repeated parts or musical guides like additional musical symbols may be changed additional musical interpretation from the conductor (EE04).

#### ***Metaphorical Interpretation by Conductor***

Feedback is presented by mixing information of symbolic elements and musical symbols, such as “Quickly as if a ship is anchored” and “As if a cat is meowing” (ED01, ED09). It is easier to understand feedback delivery than mentioning only the musical symbols.

There was a difference between practicing a piece of new music initially and feedback compared with practicing a familiar piece of music together. At first, if there was a significant tendency to guide the overall tone when the music became familiar, it tended to give detailed feedback. For example, there was more specific feedback in the string part, such as “Use the bow on top” (EE01) and the mood side guide could also be observed to explain the mood in a particular bar in the music score rather than the overall atmosphere, and the feedback was to more detailed when the performers became skilled at the music.

It may be easy to understand when it comes to feedback on metaphorical feedback, but each performer may have a slightly different way of expressing them when they were playing. It is difficult to note them in general musical symbols. Furthermore, it is an important point to practice to match the common shapes in the gestures of playing an instrument and basic technical points in how it is shown to the audience (EF02).

### 6.2.3. Feedback Recording during Musical Collaboration

The music score was used as a tool to record what happens during the ensemble practice. However, It could not always be used one's music score in a space where several people play together. Mainly, two performers have to use only one music score together, and on days when during practice. When using another performer's music score, it is necessary to record the feedback during practice separately. In that case, the performer has to do an additional record is required (EC02). In particular, in the new music, when there were many changes in the direction of the bow or musical symbol. So it was necessary to keep a separate record at the end of each music. As such, records of most feedback remain in the music score. It can get the insights that have to be obtained on what needs to be recorded.

#### *Musical Feedback on the Music Score*

As a recording of the dynamic of music, there is a record of musical symbols for additional instructions such as “piano”, “forte”, and “crescendo” although not written as musical symbols of the music score provided. In addition, there were parts where dynamic had to be expressed differently, even in the same musical note, or things that had to be recorded separately, contrary to what was previously provided (See Figure 32).



Figure 32. Dynamic Marks on Music Score

It was necessary to provide a guide to basic musical gestures like the direction of the string bow. There is a representative direction for using the bow of string, and most of them are recorded on the music score (See Figure 33).

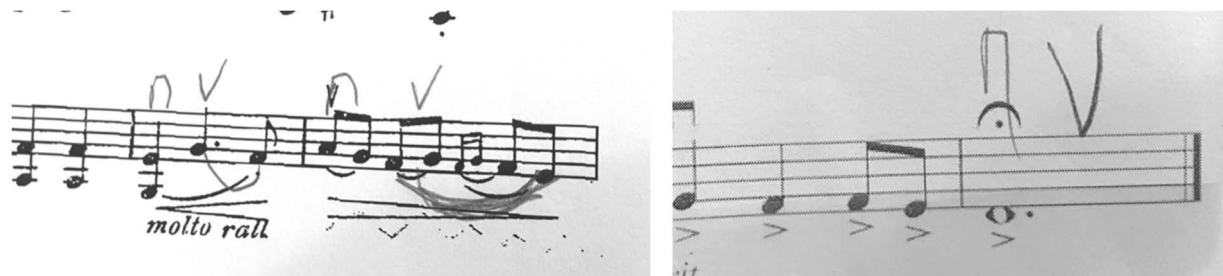


Figure 33. Guide of Bow

On a personal recording, it was separately marked the parts that require feedback points. This record is the most subjective and personal aspect and was recorded using words or shapes that are easy to understand, rather than using general musical symbols (See Figure 34).

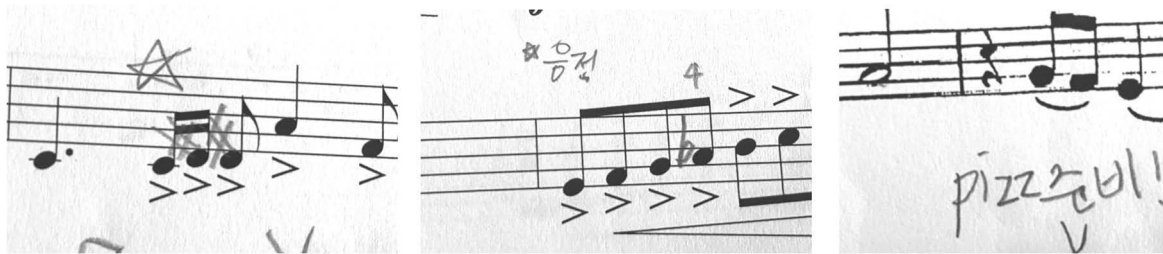


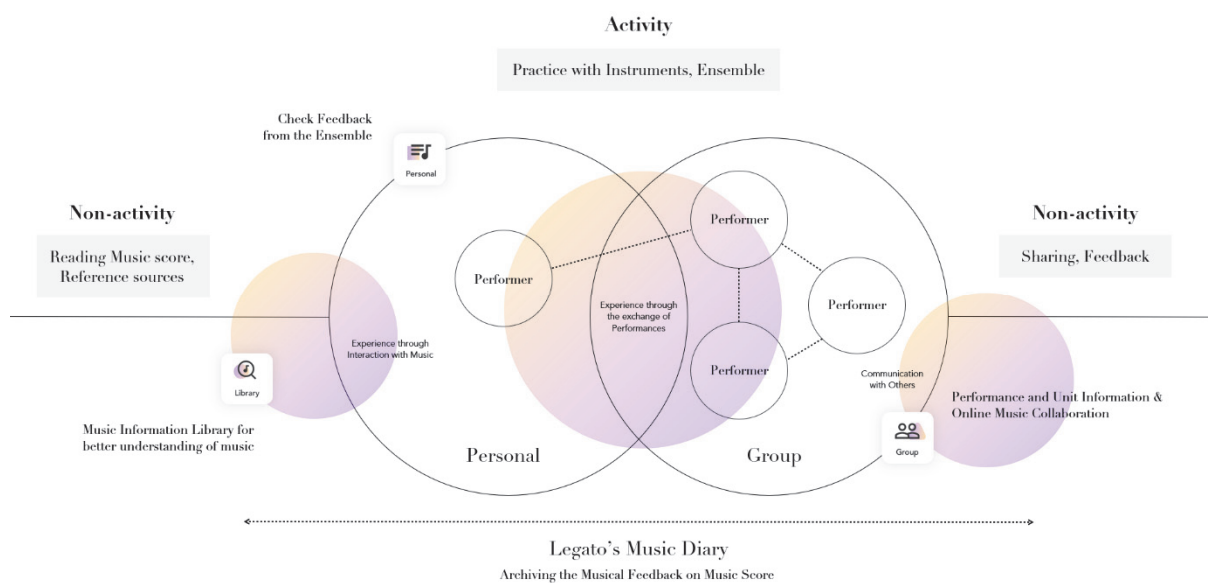
Figure 34. Careful Part

# 7. LEGATO

This chapter deliver the design result to digital products that is Legato and validate the results of the verification evaluation. Legato is an online platform for the digital transformation of classical music collaboration. Music collaboration not only defines interaction with people but also a with the music itself. So, Legato was designed with two primary purposes: collaboration with an individual's music itself and group communication with other musicians. The design outcomes were revised based on validation results. Detail screens are organized based on defined detailed features. Based on the materialized overall user flow, the design identity of Legato was expressed in keywords and mood board, and essential elements such as colors and fonts for the visual design were established.

## 7.1. The Design of Legato

Legato is an alternative solution with a classical music collaboration process is a digital platform service, in digital transformation. Legato complements the location and time limit of offline music collaboration through each feature and provides collaboration with musicians of various genres anytime, anywhere. Legato is a digital platform service that conveys the entire musical collaboration progress for the amateur musicians. It contributes to a comprehensive of the performers' experience by influencing the overall process of music collaboration, including before, during, and after practice. The function of Legato located in the each connection point for the interaction (See Figure 35).



**Figure 35. The System of Legato**

Legato seeks to solution for the problems of the existing offline music collaboration process and the ensemble way and to provide the performers with an experience of better musical collaboration. Performers preparing for the concert need rehearsal and performance space and to set the time between the performers. And there have been problems that can only leave text about the practice progress due to the volatile sound. To solve these problem, Legato uses online music collaboration and archiving auditory feedbacks of performer's progress properly through a digital platform (See Figure 36).

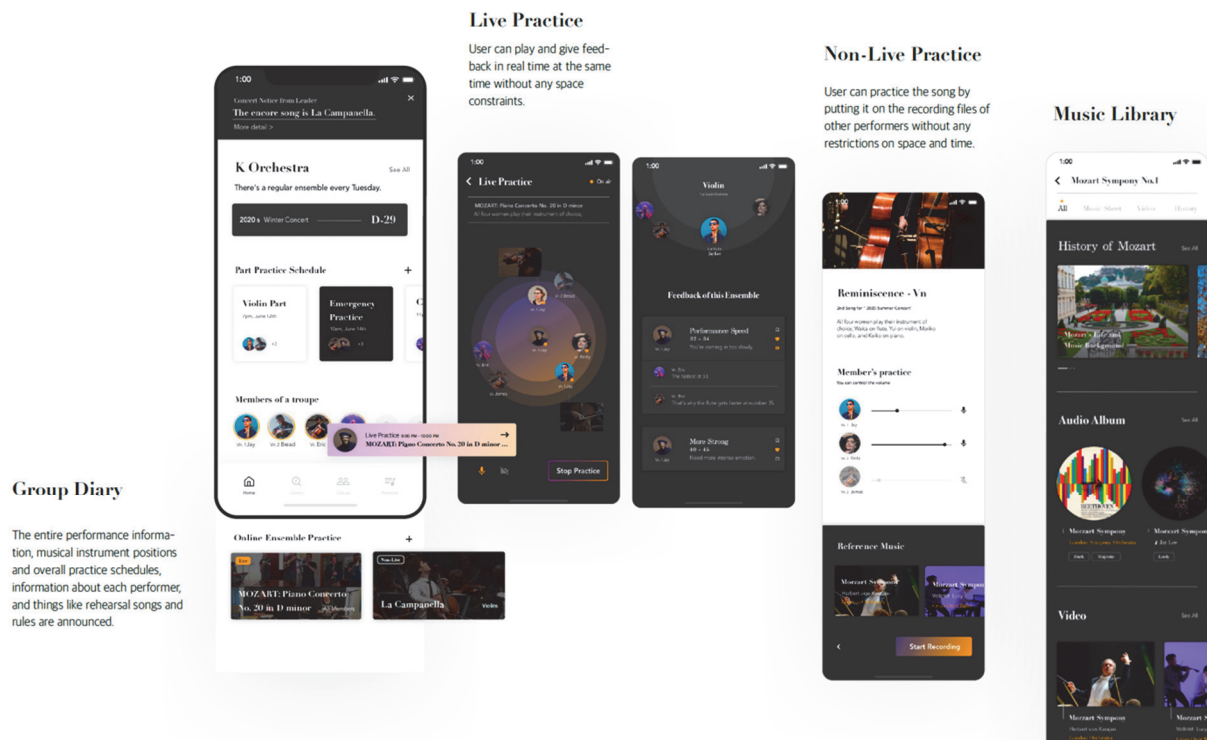


Figure 36. Legato Detailed Design Structure

### 7.1.1. Design Rationale

This project complements the location and time limit of offline collaboration and helps to collaborate with amateur musicians of various genres anytime, anywhere. Unlike in the past, when there were few opportunities for the development of musical diversity from the limitedness of musical collaboration methods, Legato has the expected effects of tentative musical development through collaboration of these various genres of music. Legato will open the possibility of a sustainable application of new technological advances to the musical areas. And it will be applicable as a solution to new music collaboration for the upcoming generation of new normal by Covid-19. By offering a new type of platform digitally driven by previous experiences, it can expect an innovative behavior change in the musical collaboration progress.

### 7.1.2. Visual Design

Visual design aims to convey the experience to users on digital platforms while maintaining traditional classical music. The traditional and luxurious atmosphere, evoking the classical architecture of classical music and the visual aspect, has been designed to convey creative possibilities to users. Mainly used serif font, lines, and dark color. Along with the depth and maturity that can be felt over the years, expressing a stable atmosphere using a dark hue as the primary color, and violet color of mysterious images was used to give points.

#### *Aesthetic Keywords and Mood Board*

Aesthetic keywords provide for the visual orientation that the project wants to provide to users. Keywords are about individuals as they go to the upper left and the lower right, the keywords presented for the group. Moreover, the association between groups of each keyword was connected. Keywords are typically composed of seven keywords, Artisan space, Friend Impression, Ambient collector, Instant capture, Creative maestro, Palace with history, and Connected rehearsal. Based on these seven main keywords, they indicated the connectivity between each keyword and the detailed keyword (See Figure 37).

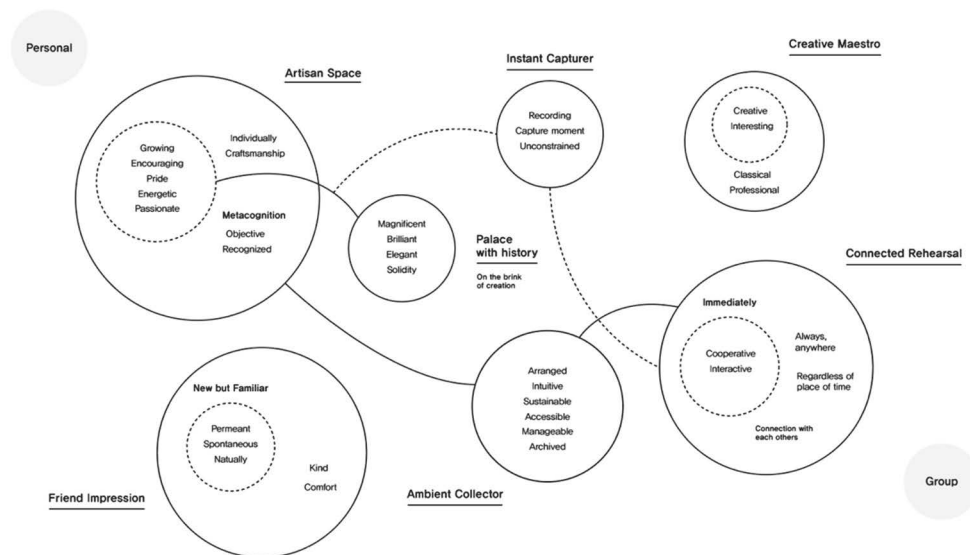


Figure 37. Aesthetic Keywords Map

Mood boards represent qualitative and visual research. It provides the creative process allowing the structure of a visual elements that offers inspirational themes, moods, colors, finishing, materials, details, product references, historical stylistic references (Brevi et al., 2019). The mood board was made according to the main seven aesthetic keywords derived earlier. The images were taken from Pinterest



and Unsplash (See Figure 38). The main contents are Didot font with refined and elegant, and the sub contents are used as Avenir font with a futuristic. As the main colors, orange and blue colors and gradient colors were used. The mode of the application is displayed in the white mode as the depth. When the background color was the dark mode, it used dark gray.

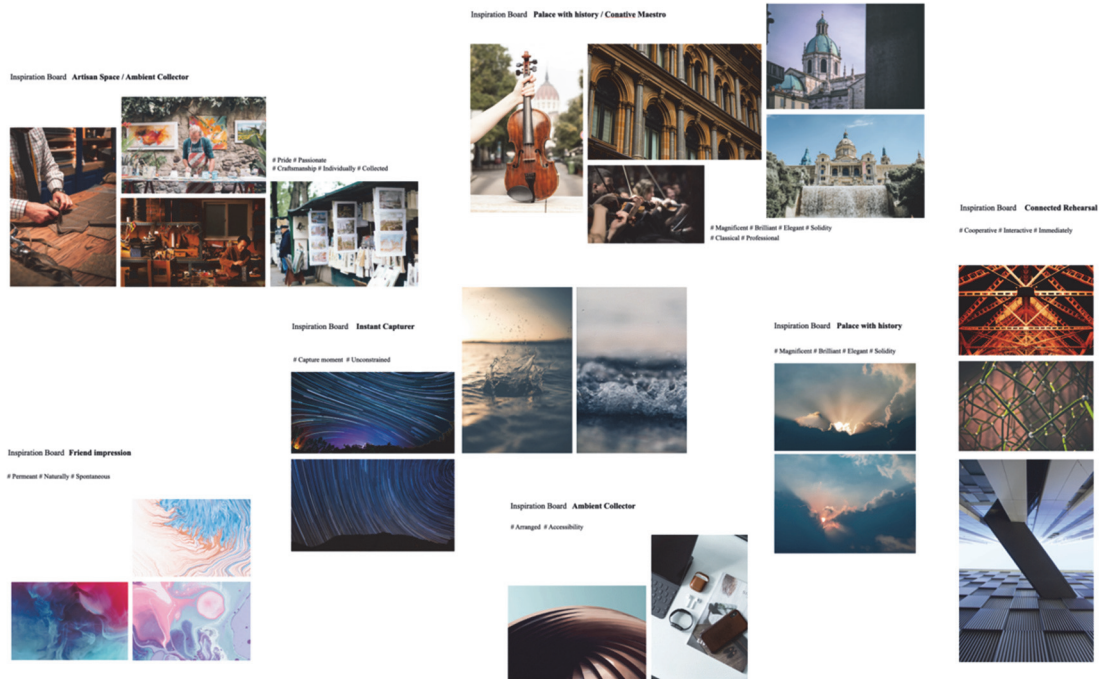


Figure 38. Mood Board (Images from Unsplash & Pinterest)

## 7.2. Design Concept of Legato

Legato consists of an application and a supported web. The purpose of the web is to improve convenience by allowing users to vary the channels performers enter depending on the situation. *Music Diary* provides visual archiving of sounds for personal music practice information, sound volume, and mood. Online Communication provides information on the overall performance and group, as well as *Live* and *Non-live Collaboration*. *Music Library* offers the information needed during practice, such as music sheets, videos and album, or music history contents. In this process, musical records are made through various methods such as text, sound, and feedback sharing.

### 7.2.1. Basic Information Access

The application is aimed at orchestras that have already been organized into groups. When the user first access to the application, the user input the basic personal information through the signup and setup page. It allows users to input whether they are group leaders or members and what position an instrument is in and to search for the group to view the same group page based on the same data cloud of information about other team members and groups in the same group (See Figure 39).

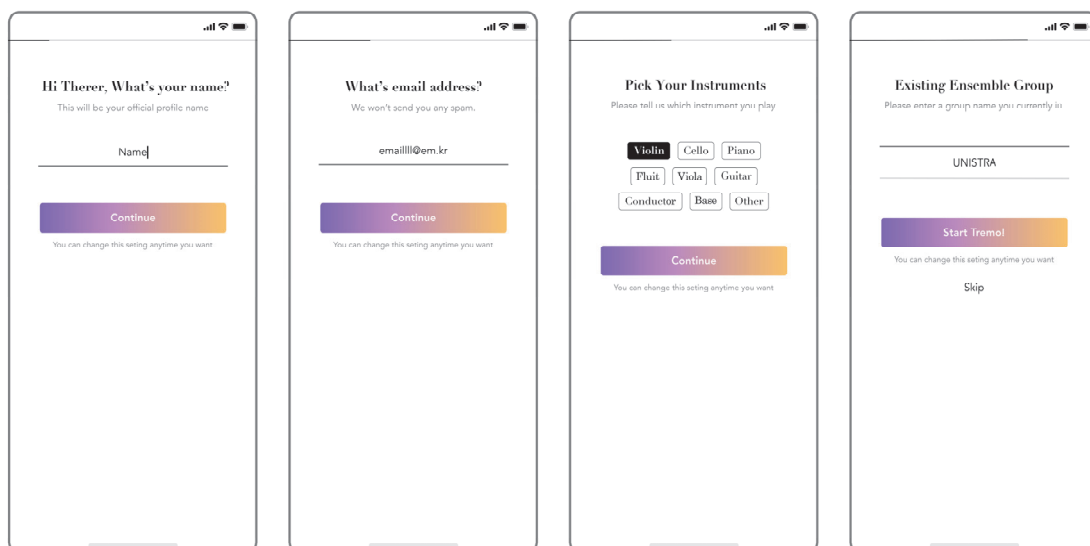


Figure 39. Basic Information Access Process

## 7.2.2. Online Collaboration

### Group Information

Internet space is a powerful tool for collaboration between people. Not only can everyone access quickly depending on the situation, but also space for information to create, and the sharing of knowledge enables smooth communication between them. Legato provides a holistic collaboration experience as online information delivery. User can share information such as performance dates, coordination of practice schedules, conditions of team members, and rules related to the ensembles. Legato enables integrated management. These Internet spaces can be made up of web or mobile application. Compared to the web, applications are more accessible to people. Various social interactions can be performed within the group. Through the application, users complete their social communities by entering information about group members belonging to the same orchestra and registering the contents (See Figure 40).

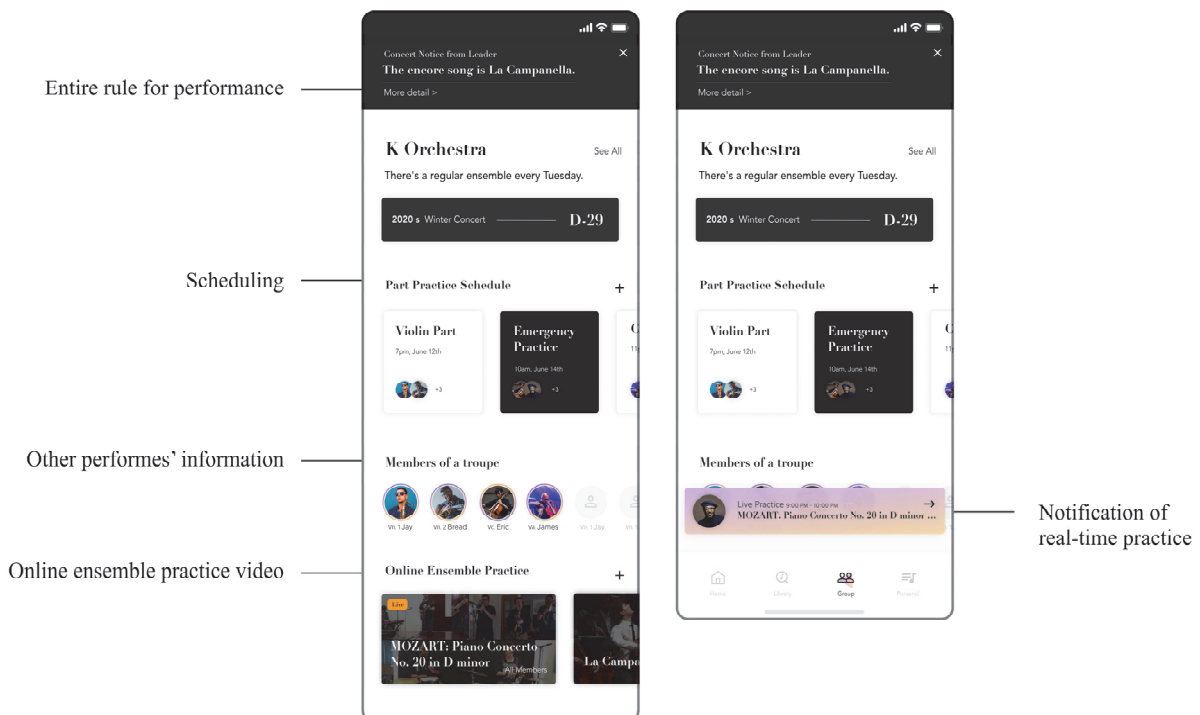
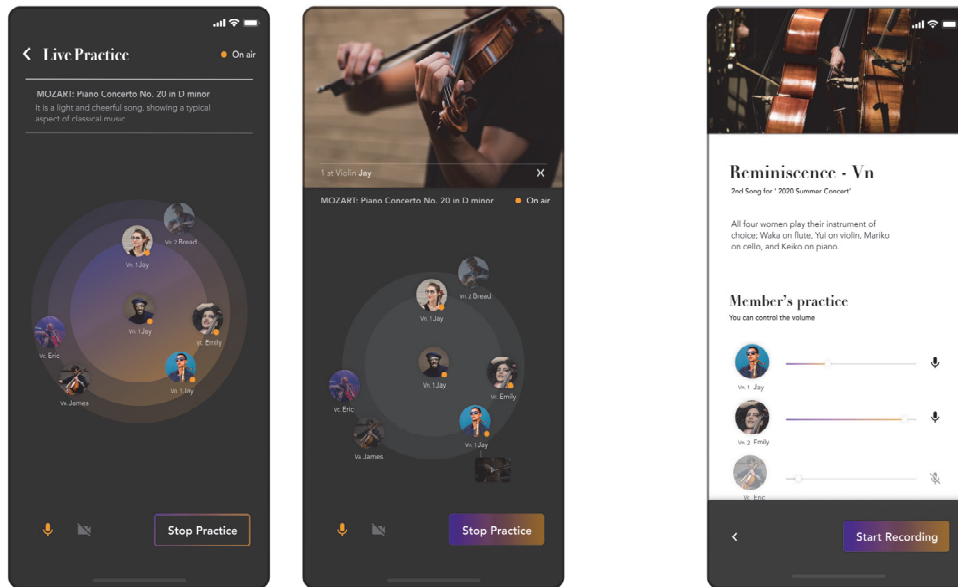


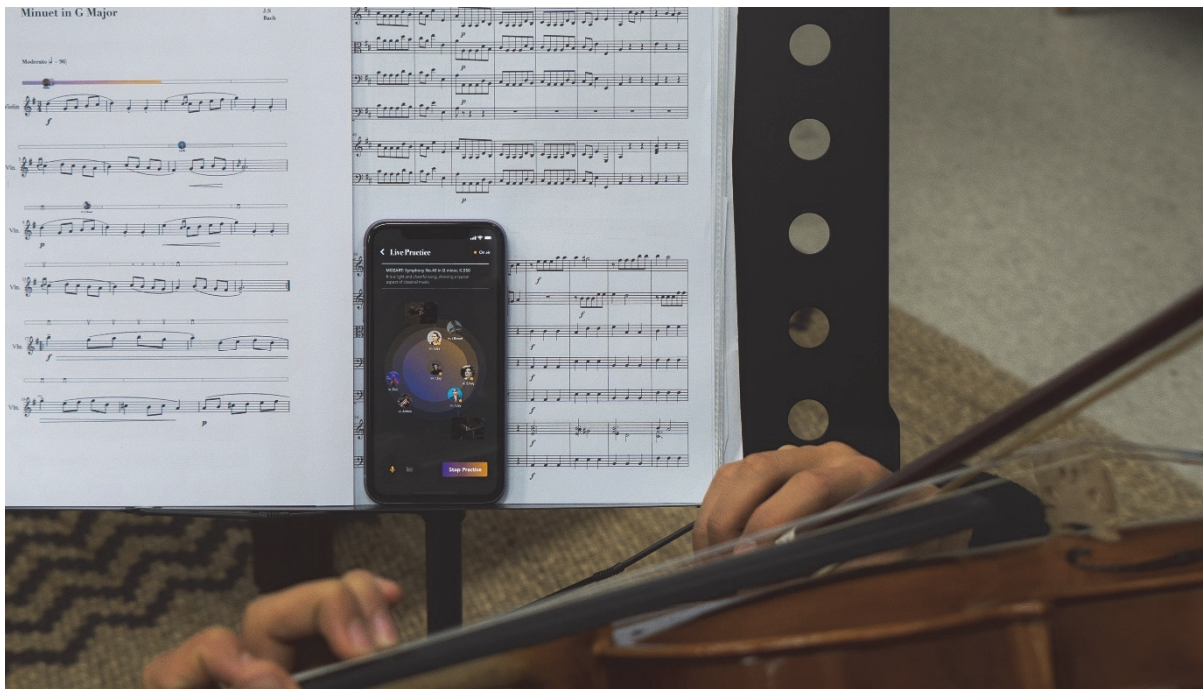
Figure 40. Group Information

**Live and Non-live Collaboration**

Online collaboration and live streaming are necessary, and the need for these existing needs is increasing with Covid-19. In terms of function, it has continuity in its purpose compared to the video upload, a single shot. *Non-live Collaboration* is a function that allows you to put notes on other performer's music or to practice listening to the bass sound.

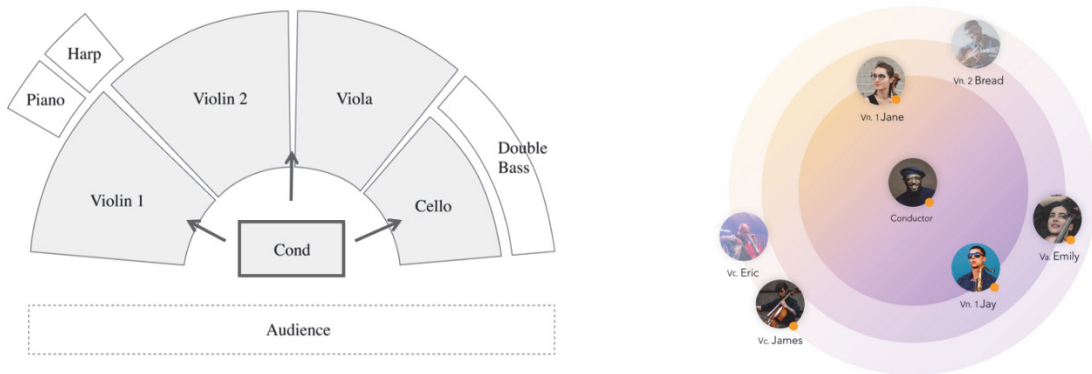


**Figure 41. Live and Non-live Collaboration**



**Figure 42. Live Collaboration in Real-time**

When organizing an orchestra seat during *Live Collaboration*, the main melody sections like violin are placed forward and the bass section like cello is placed backward. This is one way of the components of the music, as well as the position of the instrument section in terms of the audience's standards. The virtual space according to the instrument section is set so that musicians can adjust the sound scale through layout (Faller, 2004). About the arrangement during *Live Collaboration*, existing orchestras were arranged based on the audience in a shape of arch. But, virtual arrangement was designed in a circular form because it was a sound sharing between performers not for the audience directly (See Figure 43).



Example of Orchestra Arrangement in Stage

Legato's Arrangement

**Figure 43. Digital Online Music Collaboration Arrangement**

### Musical Feedback Sharing

Users can play and give feedback in real-time at the same time without any space constraints. Users can share and receive feedback on specific parts of the practice. This feature allows users to recognize individual week points.

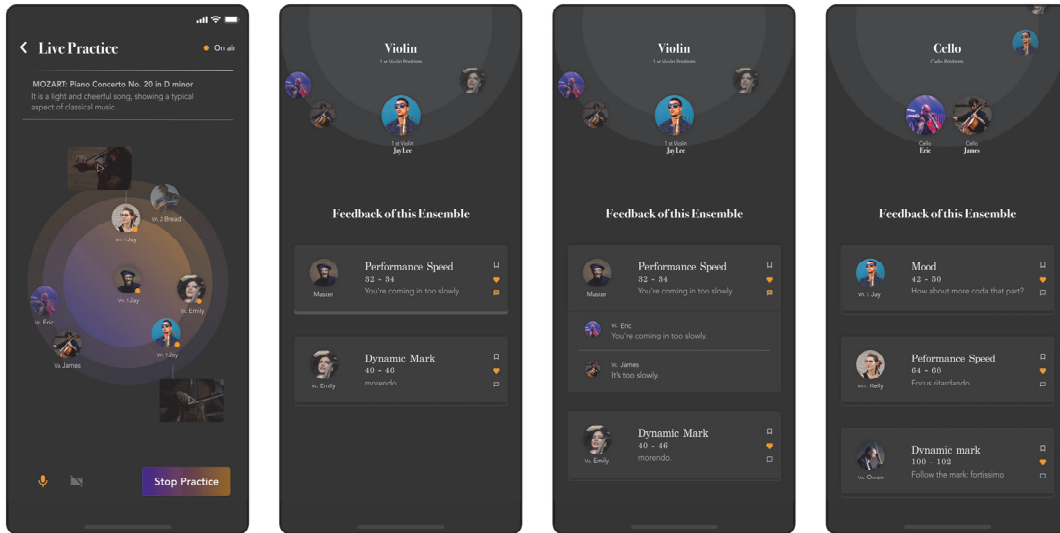


Figure 44. Feedback Sharing during Live Collaboration



Figure 45. Checking Musical feedback from Other Performers

### 7.2.3. Archiving as Digital Music Score

Users can make a simplified digital music score with the current platform design (See Figure 47). It provides visual digital archiving of classical music collaboration data with other performers' feedback. A mobile device digital music score to verify joint feedback during the performance was designed to assume that printed music score is viewed. It is designed to take the tab score characteristics and check the necessary contents on a mobile screen. The bar line of the music score is the same, so when viewed with the score, the feedback can be intuitively checked (See Figure 46).

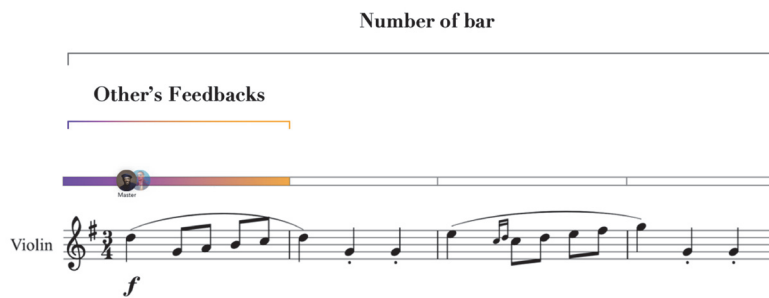


Figure 46. Method of Simplified Music Score

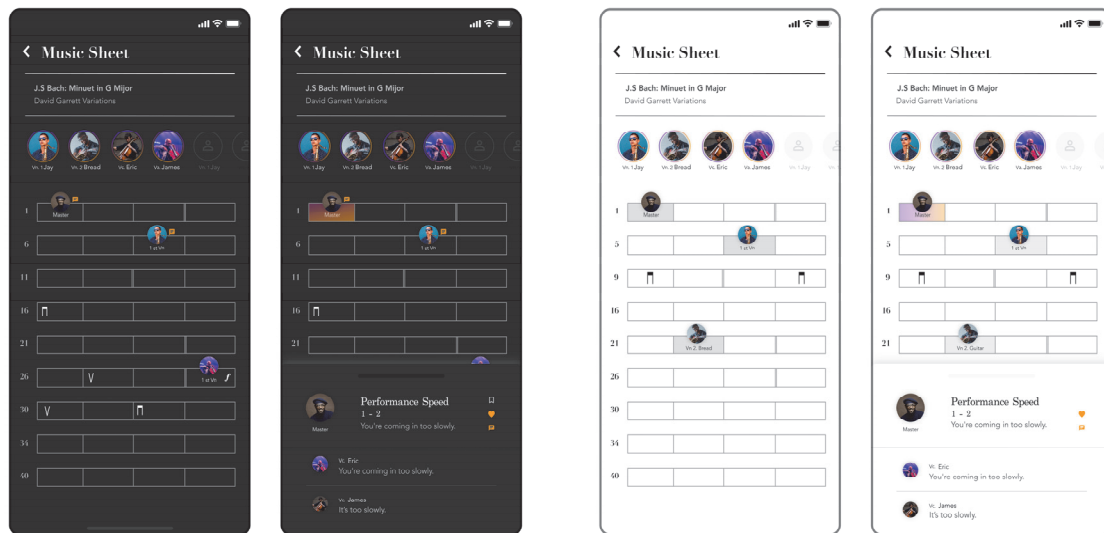


Figure 47. Digital Music Score during Real-time Collaboration (Left) and Normal (Right)

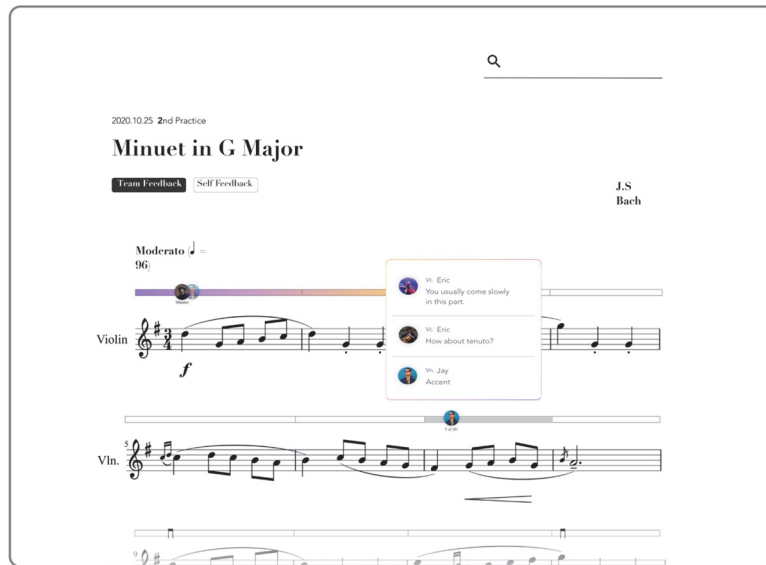


Figure 48. Digital Music Score for Web

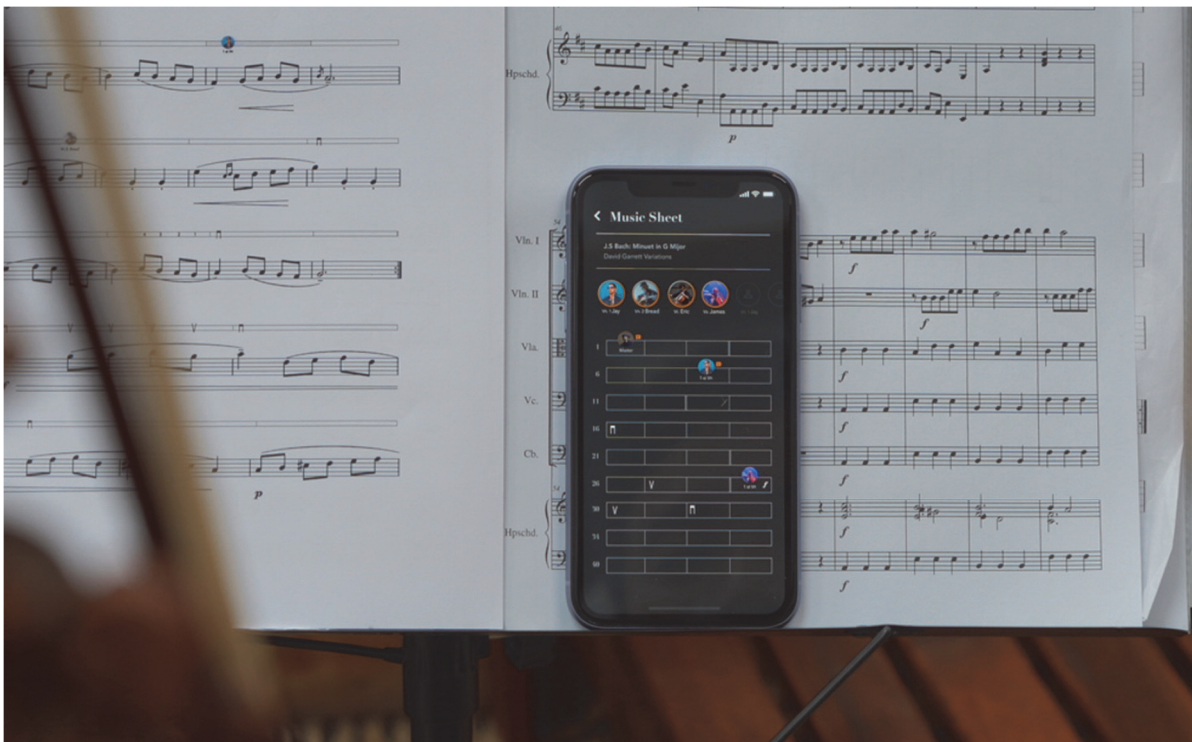


Figure 49. Digital Music Score with Paper Music Sheet



### 7.2.4. Integrated Music Library

Users can search easily for related information that was scattered sporadically at once through *Music Library*. It can easily search and find musical notes, video, or sound sources, and even text content to understand the music (See Figure 50). In *Music Library*, users can check the comments of bookmark from other performers shared for specific parts (See Figure 51).

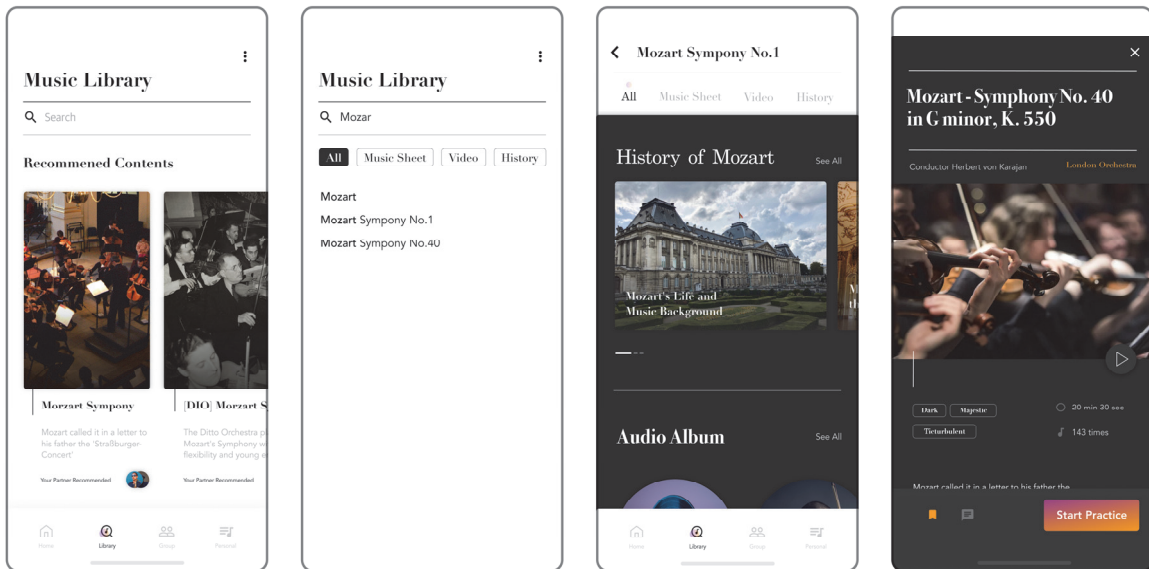


Figure 50. Music Library

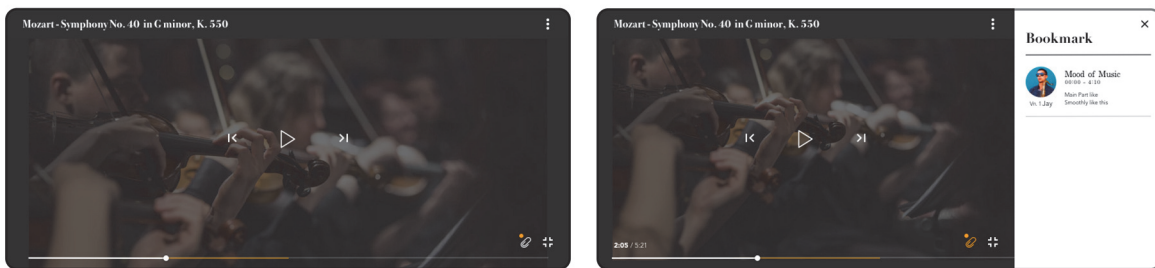


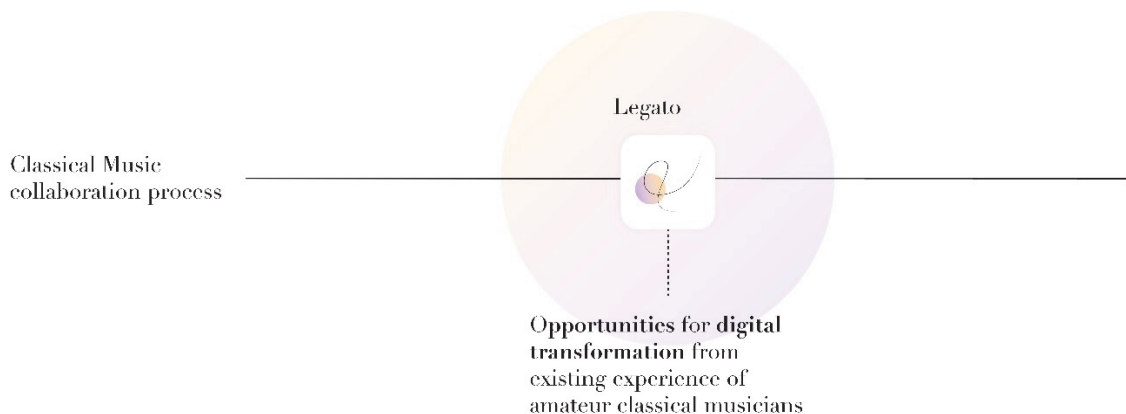
Figure 51. Comment of Bookmark from other Performer

### ***7.2.5. Cross-Device Synchronization***

Different devices are used depending on the player's exposed environment. There may be activities with active and no action. In the former case, it is exposed to the same environment as a practice room where you practice directly. It will be a space where musicians like home often stay as an environment to try. Devices used in each of these two environments can be mobile phone and table or desktop PC. Legato provides different types of score interfaces that maintain the connection of information according to the characteristics of the user's usability in the mobile environment and the web environment. It provides convenience for users to use two types of digital devices by utilizing library connectivity between mobile and web. Based on each device's advantages, the user can select and use the appropriate device for each stage during the performance process.

## 8. DISCUSSION & LIMITATION

This chapter proposes the discussion point and addresses the limitation of this project. The chapter of Design Approach was to understand the existing context of classical music's collaborative process, capture opportunities for digital transformation, and provide applicable designs through opportunities. To achieve the approach to research design, there were four stages of the integrated design process used to conduct the research. Understanding the existing domain context, the first application was achieved through online deployment and desk research and interviews during the Domain Exploration chapter, and capturing the opportunity to digital transformation, the second application, was achieved through co-creation workshops during the Design Definition chapter. In the chapter of Concept Development, the verification and modification methods were evaluated, and finally, in the chapter of Legato, it was presented as a design result. The direction of previous studies has often been technical in software-limited or audience-oriented or overall classical collaboration. This project is characterized by suggestions for systemic digitalization in the entire music process, although it is not completely talking about one area.



**Figure 52. Opportunity of Digital Transformation in Classical Music Collaboration**

### *Limitation of Implementation*

The agile process should have proceeded through several iterations after completed the development implementation, but there was a limitation to not being able to proceed to the development implementation phase. Instead, it was conducted the conceptual design. However, a lot of assumptions come from the concept design, such as the music library, the assumption that users can find every information that they want, the assumption that latency will not occur in the online real-time collaboration, and the non-live collaboration that audio balances will be provided uniformly. Therefore, there was a limitation of actual implementation errors. It can be necessary for another solution when the concept to real digital product service can use from implementation errors.

### ***Limitation of Target User***

There was a limitation of investigation into the leader's position if there was a relationship between a musician and a leader. In the structure of amateur musical collaboration, the role of professional musicians is one of the key factors. Information about professional musicians or conductors within the section was provided only through interviews with amateur musicians. In this aspect, there were limitations in the user study phase.

## 9. CONCLUSION

This project proposes an online platform for the digital transformation of existing offline classical collaboration processes. The online platform aimed to allow musicians to share before and after their careers in music collaboration. It was looked forward to effective growth based largely on the musical collaboration with individuals and groups. It was hoped that a more design approach to this field will look into how amateur classical musicians can get challenging, diverse musical access opportunities in collaboration, taking into account the new generation. Feedback and continuous digital archiving show the possibility of finding new patterns or opportunities for development in the archived information of the classical music collaboration process itself, rather than merely looking for and viewing volatile feedback or sound recording for performers. It was planned to be designed after several Iteration stages, but it still requires several verification processes. Currently, only design features of width area are designed. Therefore, further research is needed on the detailed design. Part of the research on detailed design may be more detailed research based on musicians' experience with performance cue or technical factors necessary for the actual development of applications. The risks to consider live collaboration are technical issues such as disconnected live through external Internet connectivity and quality of voice recording. As a solution to this problem, there may be a way for the Internet to solve the sink problem by matching specific beats for players who are not synchronized with the Internet and a guide for the voice quality to the user to record well. For example, a guide on a recorded phone location, such as 'Put it on a viewing stand,' might minimize the sound scale between each instrument. Before enhancing the quality of recorded voices, the goal is to provide an opportunity element through an online platform to harmonize the ensemble and make it a catalyst for groups and individuals' growth.

### *Aspects of Service Expansion*

This project provides a new type of collaboration platform for amateur musicians. Furthermore, an approach to context has been achieved in the way of immersive convergence. This project was conducted in the form of convergence in investigating a wide range of classical music contexts. The amateur musicians have a possibility of extending to become professional musicians. Amateur musicians can grow up to become professional musicians, and with the growth of these users, they have the potential to expand the scope of their customers as an online platform. Thus, it could be useful for exploring new types of users, and it could also be an extension of the service to interact with the audience.

### *Aspects of Technical*

In this project, the part about technical implementation was excluded. In this aspect, future research on the functional aspects of Legato's concept will also be needed. The possibility of research on the separation of sounds according to the frequency of instruments to the implementation of three-dimensional sound on commonly used digital devices in the functions of Live and Non-live Collaboration in Legato, research will also be needed to enable more natural online music collaboration.

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# APPENDIX

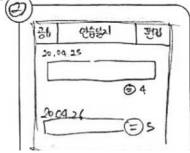
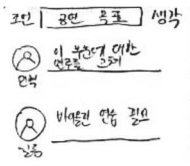
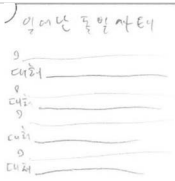

## Co-creation Workshop Results

### Group Ensemble Diary

Code	Idea Title	Idea Description
HG	Ensemble	It can check separately about problem of ensemble practice and personal practice while listening recording.
JS	Essence of Rule	It can check whether follow the rules of the orchestra.
JW	Music Note	It can note the ensemble diary as text and audio files.
KB	Don't forget the rules	It is located to check the orchestra rules in plain sight.
LM	-	-
PY	Record Diary: Improvement points	It encourages people to continue noting practice diaries and gives individuals about feedback to improve the need to practice.

Feature Title	Feature Description	Idea Sketch	Code	
Individual Practice Files	Archiving record files of personal practice		HG	A01
Choosing Instruments and Uploading about Individual Practice	Upload the audio file that practiced for the instrument, and then ensemble virtually when the other instrument files are uploaded (after all instruments upload, the color is changed).			A02
Ensemble & Feedback	Compare music score and sound that is the practice to inform the part having mistaken.			A03
Our Rules	Recognize as checklist about rules		JS	A01
Checking during Practice	Try Practice			A02

Showing the Breaking Rules	In real-time, It can show whether following the rules. (Success point is real-time about Mission accomplished)			A03
Sharing Ensemble Diary	Text and audio are recorded together. Quick sharing is possible about comments according to sound.		JW	A01
Ensemble diary	-			A02
Performance Calendar	View the entire schedule of the show on a calendar			A01
-	Use notes for checking practice condition		JH	A02
Checking practice goal attainment each section	It can check practice by section at a glance		KJ	A01
Feedback by ensemble for each note				A02
	Fix the rules to the right screen to keep them exposed and record the diary in scroll form on the left screen		KB	A01
	It can check the rule and practice diary recorded for each day of use.			A02
Section information,	It can self-search and note each section in the practice video for coordinating opinions.		LM	A01

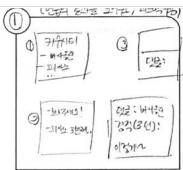
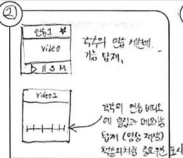


Searching and Writing note				
Sharing Practice Diary and Edit the Diary	It can provide direct feedback according to the amount of practice and sharing of comments with other performers.			A02
Leader's performance goal and Chat room each day for record	Leader can write for increasing delivery power, and it can be possible to record continuously.			03
Record Diary	There is a notice to write a diary. Provide a checklist of what to write.			A01
Feedback for each other's	Unexpected event record and post-action feedback		PY	A02
Using of Practice Diary	Compare and use practice records from 1st to 39th sessions as examples (focus practice can be done by announcing areas where individuals are not good at)			A03

**Personal Practice Diary**

Code	Idea Title	Idea Description
HG	Practice Together	It can identify and advise feedback and comment sections from the practice record data
JS	Who's better	It can find real practice time.
JW	Practice Note	It can use audio file as feedback note.
JH	Automatic Pause	It can be automatically stopped at a set time and record music.
KJ	Game Quest like Stage	It can check the achievement rate by date in the practice diary.
KB	Practice Time-Lapse	It can check several records at once and check the growth.
PY	Practice notes	It can visualize how much practice.

Feature Title	Feature Description	Idea Sketch	Code	
Self-feedback / Issues during practice / My practice diary				
Visualization for My Music	If I perform the wrong part of my practice sound, it is roughly expressed. My invisible practice looks visual.		HG	B01
My Practice Feedback	Zoom up and record my comments ex) 'Pease be careful this part.'			B02
Re-practice	The comment shows many parts statistically and feedbacks (it feels like we are practicing together) with an alarm on which part of the four-minute exercise to watch out for. When the application plays, the alarm goes off, saying, 'I made frequent mistakes in the next section, be careful.'			B03
Set goals and check achievement / Self-feedback / Issues during practice / My practice diary / Use of practice diary				
Today's Practice	Find out how long practiced today		JS	B01

Today's practice, Weekly practice, and Monthly practice	It can record the actual performing time and the total time taken each day and show them together.			B02
Comparing to another performer	Express how focused on practice comparing the overall average			B03
My practice diary / Use of practice diary				
My practice diary	It can use together with text and audio		JW	B01
Use of practice diary	It can share to friends using SNS			B02
My practice diary				
Auto pause	I want to keep listening to the music I've played and recorded, but I'm lazy to press the record button from time to time. I hope it's recorded at a fixed time and organized well.		JH	B01
Set goals and check achievement / My practice diary / Use of practice diary				
Map of achievement of goal	Get a quick, at-a-glance look at your goals		KJ	B01
Practice diary	Detailed exercises, goals, and content for each bead			B02
Set goals and check achievement / My practice diary / using the practice record				
Seeing continuously	Easily compared to past recording with exactly date		KB	B01
Select past recording in history bar	Listen to the past recording sound			B02

Self-feedback / Use of practice diary			
Make community for sharing feedback	It can write in a practice diary in the community and give feedback using comments. Ex) Three years of experience violin / Nickname: Hyuk / Comments: "Like this~ Like that~."		B01
Play, repeat, slow function	Allows users to mark mistakable parts of practicing and continue to practice		B02
-			
Set practice goal	Register your favorite performer information / Afterwards, check the goals and start practicing		B01
Use practice note	Self-feedback and reason		B02

**Musical Communication**

Code	Idea Title	Idea Description
HG	Separately and together	It can provide easy feedback to give and respond in real-time
JW	Music Zoom	It can share video call with other performers.
JH	-	It can give feedback of music note and listen to specific sections loudly in full score record.
KJ	Virtual ensemble through video	It can share practice videos and practice virtually to perform or collaborate with other performers. (Not real-time)
KB	All together	It can concentrate on performing musical instruments, even though that is video calls.
PY	Teamwork	It can visually provide intuitive information about the part that can improve and organize if someone makes a mistake while performing.

*Communication with leader (conductor or section concertmaster) and performers*

Feature Title	Feature Description	Idea Sketch	Code
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The word from the leader	You can see each member's reply to performance or reaction		HGC01
Music Zoom	It can share faces, sounds, and atmosphere (Video sharing such as Zoom)		JWC01
	Each instrument can be checked in detail by making a big listening button		JHC01
	Focus the screen of leader		KBC01
	1: Room for leader and performers 2: Room for performer 3: Room for feedback (Three windows on one screen)		LMC01
Announce about the Goal about music	Specify and practice what to perform and what atmosphere to like.		PYC01

*Communication between performers*

Feature Title	Feature Description	Idea Sketch	Code
Practice Music Review	When the group members upload their performance practice, they can cheer and give feedback right away. (Provide brief feedback with emoticons)		HGC02
Music Zoom	Various opinions can be heard in real-time		JWC02
Video call Ensemble	It is not real-time, but it is possible to practice ensemble with recorded videos.		KJC02
	The screen placed from side to side and the screen of other performers.		KBC02



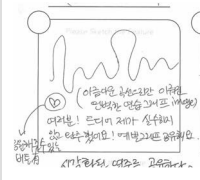
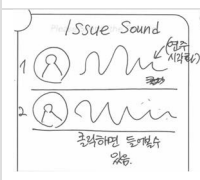
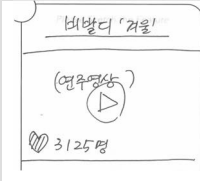
	Add new videos (practice) and comment on each caption of the ensemble / This feature enables full practice ensemble playback and exercise updates		LMC02
Mixing together	Listen to each other after a split recording and feedback		PYC02

*Sharing feedback about practice*

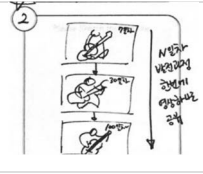
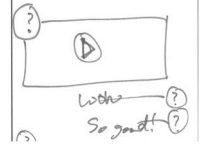
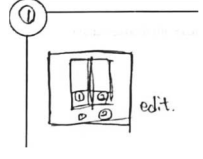
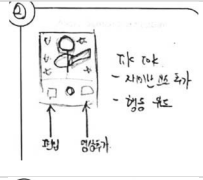



Feature Title	Feature Description	Idea Sketch	Code
Real-time feedback board like 'KakaoTalk'	It's hard to reflect on the feedback after a long time, so give me feedback like KakaoTalk to get feedback right after practicing!		HGC03
	The whole music score is used as a UI to listen to the practiced songs and comment right away on the parts that need feedback (click on the sheet music).		JHC03
Ensemble talk			KJC03
	Positive and negative feedback are mixed		KBC03
	Captioning allows you to share feedback on continuous performance (practice)!		LMC03
	Talk about each other's feelings, good things, and bad things to improve, and let them know by chatting or writing down information.		PYC03

**Personal Practice Result**

Code	Idea Title	Idea Description
HG	Competitive spirit	It stimulates the desire to win by providing access to other good performances.
JS	King of concentration	It can share how much the performer practice and what is performer's goal.
JW	MISTAKE	It can share similar mistake parts with other performers, like the SNS sharing platform.
JH	Music Free Market	It can expose the performed music in public spaces such as cafes.
KB	Look at me	It can expose to strangers and get feedback.
LM	Practice sharing and Like	
PY	Compare the Hard work	It can compare a performer's past practice records with the present in order to show growth.

Feature Title	Feature Description	Idea Sketch	Code	
When I growth and development / When I finished without mistake / When I want to get feedback				
Sharing Practice Visualization	<p>It shares a visualized performance (Curious click to hear the instrument)</p> <p>Competitive psychological stimulus</p> <p>There is also a cheering button, so you can see how many people are cheering for you.</p> <p>"Everyone! I finally successfully performed without a mistake! Let's share a beautiful graph!"</p>		HG	
Ranking	<p>The main screen has a low ranking of the music that are making headlines</p>			D02
Focusing on the Practice Music	<p>You can see and hear the performance of the person with the best record among the music you're practicing.</p>			D03
Satisfying the desire to show off / Pride points are self-PR / Self-Record				

Visualization of the Practice	Record how much I've practiced, and the best part I can share in the recording		JS	D01
Sharing Musicians' community	-			D02
Evaluate	It can share Review and Feedback			D03
Increase self-satisfaction / Constant motivation				
Increase self-satisfaction	Evaluated on SNS and getting motivation continuously		JW	D01
Share it with performers who play the same music	Gain more professional feedback and know-how			D02
Confidence / Satisfaction				
Cafe BGM	My music is used by connecting with bosses who want to use my music as a BGM, such as a cafe or a restaurant. I can also get a review of my music playing.		JH	D01
Practice log	It can share practice records with other performers			D02
Competition for practice	Practice is ranked by the quantitative amount of time recorded			D03
Development / Achievement of Goal				
Play evaluation / Challenge mission	It can do a performance challenge inside the content.		KJ	D01
Sharing				D02

progress video	<100-day Challenge >			D03
Like / Compliment / Feedback				
Look at anyone!	It can get feedback from someone who does not know. It can check the responses from the perspective of new people.		KB	D01
Comparing practice and Like	Compared video and Like for level up Left: past practice diary Right: present practice diary			D01
Interesting elements like 'Tick-Tok'	Create your own video to motivate and increase attachment to practice		LM	D02
Benefits according to practice results	Ranking and benefits based on your practice performance			D03
Self-satisfaction / Visualization of effort				
Show Personal Improvement	Video editing is possible for 10 seconds before and after practice, Evaluation of others or personal evaluation.			D01
Successfully breaking the difficulty part like F code of guitar fingering	Support other performers or keep records about self-feedback		PY	D02

### Auto-ethnography Results

EA01	불참을 하여서 카카오톡과 밴드를 통해서 연습해야 할 곡의 악보와 유튜브 영상을 확인 함
EB01	곡의 전체적인 그림은 지휘자님이 봐주시고, 각 포지션별 악장님이 세부적인 부분에 대한 가이드를 해줌
EB02	2 바이올린 파트의 악장 선생님이 내가 연주를 잘 못 따라 가는 순간때, 옆에서 같이 연주 함
EB03	‘전체적인 분위기가 너무 짜진다.’ 지휘자님이 크게 곡의 분위기를 전달
EB04	특정 마디를 언급하여 그 부분 부터 부분 연습을 함
EB05	‘여기는 부드럽게 끝내고’ 혹은 ‘몇마디 몇박에 포르테 추가’ 같은 피드백
EB6	활의 방향을 반복적으로 지웠다 썼다 함
EB07	처음 받은 곡에 대해서는 음정 하나하나 속도 맞춰서 따라가는데 급급하게 연습함
EB08	특정 마디 연습 시 일일이 마디를 세어봐야 하는 경우가 있음
EB09	특정음이 반복이 많이 되는 부분은 다른 주요 멜로디를 들으면서 음이 바뀌는 부분을 캐치해서 같이 들어오는게 중요함
EC01	연습 당일에 2 바이올린 특방에 악장님이 활 방향 체크한 이미지 업로드 와 함께 ‘연습 전에 활 방향 체크해서 오세요.’ 라고 채팅방에 공지를 따로 주심
EC02	보면대 하나를 2 명이서 사용을 하는데, 같이 옆에서 연주하는 분의 악보를 사용할 경우에, 합주 중간중간에 곡이 끝날때마다 변경된 사항을 사진으로 찍어둠
EC03	합주 중간중간에 1 바이올린 따로 해보고, 2 바이올린 따로 해보고 하면서 각 포지션별 소리를 따로 피드백 해줌
EC04	모든 포지션이 어려운 부분과 특정 포지션이 어려운 부분이 있는데, 전자의 경우는 같이 특정 마디를 연습하는 경우가 많았고, 후자의 경우에는 특정 포지션 별로 해봄
EC05	연습 도중에 음을 놓치더라도 활은 맞춰줘야 함
ED01	‘음이 너무 투박하다.’ ‘배가 다가 오는거 같은 느낌으로 점점 세고 빠르게’
ED02	‘캐리비안의 해적 보면 배가 정박하면서 들어오는 듯한 느낌으로’
EE01	새로 들어가는 곡이 박자기 헛갈리는 부분이라 포지션별로 박자 연습을 해봄

ED03	da capo (D.S.) 부분에서 반복되는 순서가 전체적으로 헛갈려 함
ED04	47 마디 세게하는 부분 강조 해줌
ED05	중간에 템포가 빨라지고 느려지는 부분 주의를 줌
ED06	크레센도, 디크레센도 부분 주의를 줌
ED07	60 마디에서 작게 시작하는 것 주의를 줌
ED08	‘가요니까 노래하는 듯한 느낌으로 연주 해주세요.’
ED09	‘고양이가 냐옹 거리는 부분에서..’
ED10	템포가 특히 빠른 부분은 반복 연습을 함
EE01	특정곡에서 현파트는 전체적으로 piano (p) 부분에서 활을 아랫쪽에서 사용하다가 f로 올수록 활을 위쪽으로 길게 사용하라고 함
EE02	29 마디에서 시작하죠. 라고 하는데 마디 찾기가 힘들어서 어디냐고 물어봄
EE03	박자가 빠르고 음이 많은 부분은 같은 구간을 느리게, 천천히 반복해서 함
EE04	181 마디에 meno piano (mp) 추가 해주세요.
EF01	‘여기는 끝나고 활을 붙이고 있다가 제 지휘 맞춰서 같이 떼야되요.’
EF02	‘곡의 시작과 끝을 동일하게 맞추는게 중요한데, 마지막에 끝날 때, 동일하게 우리 현 파트들이 활을 들어올리면서 끝나면 듣기에도 소리가 더 좋아요.’

### Legato Design Concept Video Link

<https://youtu.be/a05bU4akqGA>

**Legato: an Online Platform for Virtual Collaboration of Amateur Classical Musicians**

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This book is based on my Master Graduation Project, but *not* an official publication.

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