Interactive Concert Programs Software for Enhancing Live Performances

By

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Abstract

Concerts and live performances are usually better appreciated when additional information about the exhibition and the performers are provided. For centuries, printed pamphlets or booklets have been the common way to provide the audiences with this information. Unfortunately, printed programs are not always the most efficient solution: they typically contain too much data to be read in a few minutes preceding the concert, and after the performance they are usually thrown away. More crucial, printed information cannot be synchronized with the ongoing concert, and the spectator has to constantly connect the data on the paper with what is happening on the stage. Technology can overcome this problem. *Interactive Concert Programs* (ICP) is a software that allows the streaming of digital information (such as text, images, or links) to the mobile devices of an audience in real time. Data can be triggered at a specific moment, according to what is performed. Moreover, any spectator can autonomously navigate the information streamed, using his/her device. ICP combines the characteristics of a *slideshow software* such as PowerPoint, and of a *hypertext*, such as HTML pages. There are several advantages of using ICP instead of printed programs. The listening experience can be guided with relevant information through all the duration of the event. Multilingual translations can be easily provided, as well as explaining texts for the Deaf. Users can save and share on social media the most interesting information, thus engaging new potential public. Lastly, the editing process of concert programs would be drastically simplified, and with a remarkable saving of printed paper. In this historical moment when performing arts can be difficult to understand and be appreciated, ICP can easily and inexpensively turn any theater or stage into a big lecture room,

providing a new effective way for artists to tell the audience their artistic vision and the story behind the artwork performed. The audience would assimilate information more easily, with a better understanding and appreciation of the performances.

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Chapter 1

Introduction[1]

One of the biggest challenges for a theater or an orchestra company is to engage the audience and make sure that the public enjoys the concerts and keeps coming to every concert of the current and following season. Recent research from the National Endowment for the Arts (Silber & Triplett, 2015) highlighted that the audience of performing arts has significantly decreased in the decade 2002-2012. The percentage of U.S. adults attending a performing art activity at least once in the past 12 months dropped in every genre.[2] Moreover, from the demographic distribution of the audience observed in that study, it is clear that performing arts lack in engaging important segments of their potential audience, such as people of non-white ethnicities or people of ages 18-24. If this trend remains, many concert halls and theaters will be facing financial crisis and risk closure. As a consequence, attending performing art events would become even more difficult, with an alarming impact on society. In fact, the arts play an important role in connecting people with their souls and emotions: as former US Secretary of Education William Bennett said, the arts "are an essential element of education, just like reading, writing, and arithmetic... music, dance, painting, and theater are all keys that unlock profound human understanding and accomplishment" (NPAC Staff, 2012).

One of the reasons for this decreasing interest in performing arts, is that they require a deeper focus and comprehension than other lighter forms of entertainment. Quoting Johnson (2002): "A piece of music is no different than a poem or a painting. To understand a poem, one has to

[1] A previous version of this paper was accepted at peer-reviewed international ACM Conference on Hypertext and Social Media (HT), July 2017, and published in the conference proceedings (Cipriano, 2017).

[2] The percentages recorded in the U.S. in 2002 and 2012 for the different genres are: jazz (10.8%-8.1%); classical music (11.6%-8.8%); opera (3.2%-2.1%); musical plays (17.1%-15.2%); non musical plays (12.3%-8.3%); ballet (3.9%-2.7%); other dances (6.3%-5.6%).

be literate not only in language, but also in the formal conventions of the poetic genre and the broader tradition of poetry." According to him, "the goal of our relationship with music-as-art is understanding." As a consequence, if we want the performing arts to return being a regular part of people's entertainment and personal growth, it is crucial to give people easy and efficient ways to understand the artworks, the artists, as well as the history and the ideas beyond the creative process. One common way to help the audience understand a live concert is to provide printed information about the work performed and the artists involved. As society has become very technologically-oriented in the last decade, some modern approaches could be more effective than the traditional printed paper.

The goal of the current work is to develop a software able to enrich any performance in theaters or concert halls, streaming real-time information on the audience's devices. The information provided should help the participants to better understand and enjoy the performances, leading to further engagement of the audience. *Interactive Concert Programs* (ICP) software has been developed to this aim. It has been tested in a few pilot studies, which helped tune the technology and led to an experiment at the University of Kansas that involved the use of ICP during a symphonic concert. In that experiment, ICP received very positive feedback from the participants. ICP is now in a beta version. One of the main advantages of ICP is its full compatibility with all the modern and future devices, since its technology is based on HTML and Javascript. Hopefully, a few years from now, wearable technologies for augmented reality, such as Google Glasses and Virtual Reality headsets, will become more accessible and common. At that point, ICP will be immediately available to be used on these devices. This could open the doors to the concept of *augmented live performances*, i.e. live concerts where additional layers of information are digitally provided to the viewers in real time.

This DMA document explains the reasons behind ICP, its design principles, the experiment performed, as well as its possible applications and improvements. In section 2 we first present some traditional and modern ways to provide the audience with information about a concert and its performers; then, we briefly discuss some key features of slideshow and hypertext software,

addressing their relation to the task of providing effective concert programs. Section 3 illustrates the ICP software, from its general principles to a more detailed explanation of its components and technologies; the links to access and try this technology are provided at the end of the section. Section 4 describes and discusses an experiment performed at the University of Kansas that used ICP during a symphonic concert. In section 5, some major applications of ICP are examined. Section 6 addresses some ideas that would improve ICP and some additional experiments that need to be performed to measure its effectiveness. Section 7 draws the conclusions of the present work.

Chapter 2

State of the Art

Concert programs are traditionally provided in theaters as pamphlets incorporating information about the music to be performed, the ensemble, the conductor, and the soloists. Renowned concert halls may provide big booklets containing extensive information, such as state-of-the-art musicology studies, broad listening guides, and commented excerpts of the music (as in Teatro La Fenice, 2017; Metropolitan Opera, 2017). In the case of opera houses, the concert program includes the libretto of the opera, usually both in the original language and in English. Moreover, opera houses provide supertitles with translations on the top of the stage or small screens in the backs of the seats (Tommasini, 1995; Smith, 1997). These supertitles are synchronized with the music, but they only address the translations of the words. The use of supertitles during opera performances is sometimes questioned, as it could "take our minds and focus away from the music and all its richness" (Plotkin, 2015). Nevertheless, all the major opera houses provide them.

Currently, information about the music and the performers is mainly provided in printed concert programs, thus limiting the possibilities of guiding the listening experience throughout the performance, as in the dark of the ongoing concert reading becomes difficult. Moreover, Margulis (2010) points out that in some cases, "prefacing an excerpt with a text description reduces enjoyment of the music." A different, more technology-based approach, could challenge this results and lead to more enjoyment when attending live music.

A technological approach has been attempted in 2004 with the Concert Companion (Valliere & Latzky, 2004), a personal digital assistant (PDA) provided to participants wishing to use it for receiving commentary and images during a live performance. This technology has not become popular as hoped, likely for the cost of the PDAs, that were expected to be rented by the users

at every concert. Other technological approaches have been tried. For example, in more informal settings, such as family concerts, educational projects or avant-guard exhibitions, the performances are sometimes enriched with texts and photos projected on a screen on stage (for a more detailed discussion, see Brown, 2004). A slideshow presentation software is commonly used in these situations, with a person following the concert and triggering the slides accordingly. This approach adds some interesting features to the performance, such as the ability to guide the listening experience and the possibility of counterbalancing sounds with words or images. However, some disadvantages still take place: the projector could not be clearly visible from all the seats of the hall; the light of the projector could interfere with the lights designed for the performance; people not interested in the visual information are forced to receive it; also, people cannot stop the presentation to focus on or examine a specific slide.

This last aspect is common to all the *slideshow* presentation software: the presenter typically sets the time for each slide, which are presented one after another, in a linear fashion. Of course, in the last twenty years presentation software have evolved, trying to overcome their linear, static nature. For example, PowerPoint and Keynote can include hyperlinks to other presentations or to external resources, such as web pages or videos, that could be activated by the presenter, thus breaking the linearity of a presentation. Prezi (Safar, 2015) is a recent presentation software that breaks the sequentiality of the slides, placing them in a big bi-dimensional (or even tri-dimensional) space. In this way, the viewers can see how the individual slides fit together to form a larger picture. Even with these innovations, two main disadvantages remain: 1) from the viewer's perspective, the slides are always received in a linear order; 2) there is no possibility to break this uni-directional flow of information as decided by the presenter.

In a situation where people are properly engaged and sincerely interested in what they are attending, they would typically prefer to look autonomously for specific information, investigating in more depth what touches their curiosity. This possibility is typical of the *hypertext* (and of the whole Web, which is a huge hypertext): the users navigate links following a stream of related information, in order to increase their knowledge on a subject. Hypertexts provide the freedom of

browsing information autonomously, but their navigation cannot be easily synchronized to a live performance.

Developing a new concept for digital concert programs should address theaters and audiences' needs by incorporating the benefits of both the slideshow and the hypertext paradigms. The new concert programs should trigger real-time performance-related information like in a slideshow, still giving every single person the chance to investigate what interests him/her more, like in a hypertext. As mobile devices have become more popular in the last two decades (Philips, 2014), they could be the best tool for achieving this goal. In fact, they can deliver easy to navigate real-time information to the audience. Moreover, concert halls and theaters would not need to cover any additional cost on equipment to provide this service, since it would rely on the devices already owned by the audience.

Chapter 3

Interactive Concert Programs Software

The *Interactive Concert Programs* (ICP) Software is a web application that allows venues to simultaneously stream visual information (texts or images) to multiple devices, such as mobile phones, tablets, and computers. The concept is similar to a PowerPoint presentation, where viewers are shown a series of information and images in a linear fashion. In this case, the slides are triggered by a person from a web back-end, and the information gets projected on the screen of every device connected to the application.[1] All the devices are simultaneously updated, roughly within half a second from the moment the person triggers a new slide.

The user can passively follow the information streamed or actively interact with them: he/she can go back and forth between the slides streamed so far, and can surf the links provided in the slides. The links can bring the user to pages designed for that specific presentation or to external websites (such as Wikipedia pages or personal/companies websites). Independently from the slide or web page visualized, there is always the possibility to instantly return to the presentation, right to the slide currently streamed.

Thanks to the possibility of navigating the slides and the links, the user can break the linear path of a traditional presentation and potentially surf the whole web. For this reason, the ICP system embeds the characteristics of both a *presentation software* (information are shown in linear slides,

[1] Since ICP is intended to be used in live performances requiring synchronization, the slides are intentionally designed to be triggered manually. In fact, during live performances, many factors can suddenly change the timing of the concert: an actor forgetting a line, a soloist taking more or less time than usual on a cadenza, a conductor taking a piece at a faster or slower tempo than expected. In the theater world, all the timing-sensitive tasks of a performance (e.g., curtain, light cues, stage rotation, change of scenes, supertitles) are always handled live by a specific person. It could be interesting to create a software able to track the progression of the concert, and to trigger specific events at the right moment. This software could be very challenging to develop, as it would involve complex speech recognition (on different actors, with different accents) and frequency recognition (on multiple and simultaneous pitches and timbres). Such a project goes beyond the goals of the current work.

triggered by a guide) and a *hypertext* (the user can follow the links, looking for the information in which he/she is more interested).

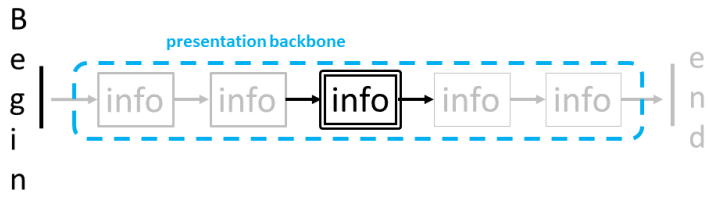

Figure 3.1: Information accessed by the user of a traditional presentation

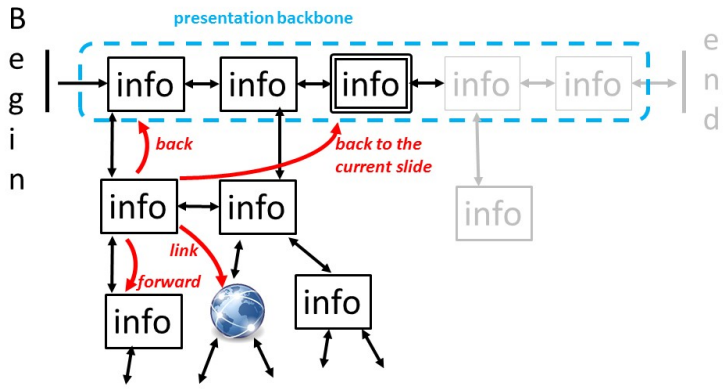

Figure 3.2: Information accessed by the user of a ICP presentation

Figure 3.1 and 3.2 show how a user accesses information during a traditional presentation or an ICP presentation. The double-line square represents the slides currently projected while the gray squares represent the nonaccessible slides. The black straight arrows represent the directions the user can navigate to, while the red curved arrows represent the slides that can be reached with a single user action (such as simple click or tap). In a traditional presentation, the slides are presented to the user one by one, and at a given time the user can visualize only the slide selected by the presenter. The previous slides are hidden, as well as the following ones. The scenario is different for an ICP presentation: all the slides previous to the current one are still accessible, with the black arrows allowing to move backward and forward. The links allow moving from the presentation backbone, thus obtaining additional information. The slides following the current one

have not been unlocked yet, so they are not accessible. In this way, the viewer cannot anticipate (thus spoiling) the contents that are about to come. The red curved arrows show how the user can move from any slide: going back, going forward, following a link, returning to the current slide. Comparing figure 3.1 and 3.2, it is easy to notice that at any given time ICP allows the user to access more information than a traditional slideshow software.

3.1 ICP principles

The goal of ICP is to enrich a live performance with real-time information. This information should be:

1. easy to produce;
2. easy to access;
3. minimally distracting for anyone else who wants to follow the concert without using ICP.

In order to reach these expectations, the following characteristics have been guaranteed while developing the ICP Software:

- producing ICP slides should be an easy and fast process; the possibility of reusing text already available is extremely encouraged, for example through cut-and-paste operations (principle 1);
- the interaction of the user is not required (principle 2 and 3); the user can simply look at the device and will still receive all the information necessary to enjoy the performance;
- the interaction of the user would be limited to a few simple actions (principle 2 and 3); these actions include going back and forth, as well as navigating the links;
- whatever part of the presentation (or web) the user is browsing, there should always be a 'safe' button that immediately brings him/her to the most recent triggered slide (principle 2);

- the size of the words in a slide should auto-adjust, to be as big as possible and to fit the screen size; this would both maximize the readability and release the user from resizing/scrolling the page (principle 2);

- colors used in the slides should maximize the readability (principle 2), without distracting other people in the hall (principle 3); to this aim, the application has followed the precautions pointed out in Anthony (2011); Hooker & Perron (2003); WebdesignerDepot Staff (2016). For example, the background color of the screen is set to black, to minimize the brightness of the multiple screens active in a concert hall. Also, the color of the words is ivory, which has a yellow/beige quality assuring high readability, without too much brightness.

3.2 ICP design

ICP is made of three components:

1. an *editor*, to create the slides;

2. a *control-room*, to start a presentation and trigger the slides;

3. a *viewer*, to visualize and navigate the slides.

The control-room runs the slides on a specific web address, shared with the viewers. The viewers can navigate the ICP presentation browsing that web address with any browser, without any need of authentication or downloading an application. A control-room can have multiple viewers, while a viewer (i.e., a single page of a browser) can access only one presentation at a time. The communication between the control-room and the viewers happens through the shared web address. Once connected to the specific address, the screen of the viewer visualizes texts or images triggered as the live performance goes on.

The main goal of ICP is to give the user both the ability to follow the slides as streamed in traditional presentation, and the chance to interact with the information as in a hypertext. To this aim it is crucial to clearly define the responsibilities of the control-room and the viewer. *The*

control-room notifies the viewer of the progress of the slides. The viewer decides to either follow the progress of the slides (with the times set by the control-room), or to autonomously navigate the information. Let's analyze these components more in depth.

Control-room

The main actions of a control-room are to *load a presentation* and to *trigger the slides*. These actions are performed by a person operating on the control-room backend. Slides can be triggered by either selecting a desired slide or invoking a *nextslide* command. When this happens, the control-room *notifies all the viewers* connected to the presentation that a new slide has been triggered.

Viewer

Once connected to the web address, the viewer waits for notification from the control-room. The viewer has two main *statuses*: *live*, meaning that it is visualizing the latest slide and wants to be updated as soon as the next slides is triggered by the control-room; *surfing*, meaning that it is freely browsing the slides or the links and it is not interested in instant updates.

Whenever the viewer receives the notification that a new slide has been triggered, it has two options, according to his status:

1. if *live*, it fetches the new slide triggered and visualizes it;
2. if *surfing*, it memorizes the information about the new slide, but it stays on the page currently visualized;

In this way, if the user decides to navigate the slides, his/her activity is not interrupted by a new slide triggered. As the new slide is memorized, the user can jump to it with a single action at any time.

The user can interact with the information streamed using one of the following *actions*:

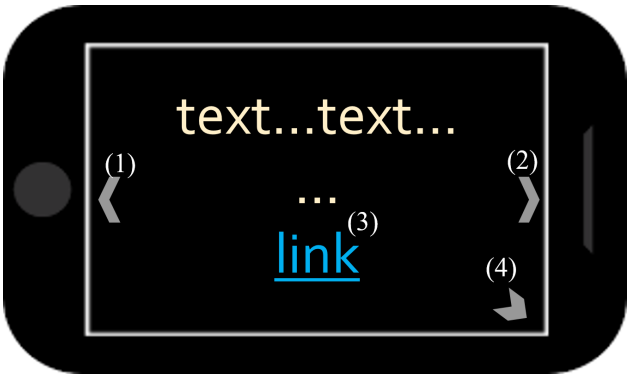

Figure 3.3: The interface of a smartphone running an ICP slide

1. *backward*: it visualizes the previous slide;

2. *forward*: it visualizes the following slide, but cannot access slides that have not yet been triggered by the control-room;

3. *click-on-link*: if a slide contains a link, the user can click on it and the corresponding page will open, letting him/her out from the presentation backbone. To return to the presentation backbone, the user can use either the "backward" action or the "go-to-the-current-slide" action;

4. *go-to-the-current-slide*: it visualizes the latest slide triggered by the control-room, bringing the user to the most advanced point on the presentation backbone.

Figure 3.3 shows the screen of a smartphone visualizing an ICP slide. The four actions that the user can perform are highlighted by the numbers in parenthesis.

The viewer starts with a *live* status, which can be changed during the presentation, according to the viewer's actions: *back*, *forward* and *click-on-link* typically switch the status to *surf*; *go-to-the-current-slide* restores the *live* status. If, after a few *back* actions, enough *forward* actions are performed to bring the viewer to the most recent slide, then the *live* status is also restored.

Editor

This component provides an easy and fast way to generate ICP slides. It mainly consists in a text-box where the user can type or cut-and-paste the text of the slides. To separate the text into different slides, the user has to add an empty line in the text. *An empty line means a new slide, so the text between two empty lines will belong to the same slide*. Thus, even generating a slide from a long text (such as the lyrics of an opera) is as easy as cutting and pasting the whole text and add some empty lines. It is also possible to add some editing to the text, such as the standard underlined, italicized or bold options. Inserting an external link in the text is performed in three steps: the user 1) selects the word that will contain the link, 2) types the link address in an input box, and 3) confirms with a click.

A preview of the slides is visualized on the side of the textbox and is updated every time some new text is typed or pasted. Once the slides appear as desired, a save button will generate them and store them in the specified directory.

3.3 Technology at work

Each module of the ICP Software has been realized following the Model-View-Controller paradigm, using state-of-the-art web technologies, such as HTML 5, CSS 3, and Javascript. The server side of the web application has been developed using the Node.js platform. The key idea beyond ICP is that every 'slide' that will be streamed on the mobile devices is an HTML page. The editor generates the HTML files, the control-room sets which slide is currently on air, the viewer decides which slide will be visualized and fetches the corresponding HTML file.

The *editor* parses the text inserted in its textbox and generates multiple HTML pages. The HTML pages are saved using names with the form $[prefix][index][extension]$: $[prefix]$ is usually the string p (but it could be arbitrarily chosen); $[index]$ is an incremental number of four digits, starting from 0000; $[extension]$ is typically the string *.html*, but it could be a different string.[2]

[2]The extension can be changed to allow compatibility with presentation software like PowerPoint. For example, it is possible to export a PowerPoint presentation into several image files, usually named Slide1.jpg, Slide2.jpg and so

For example, if the editor generates 5 slides, it will generate the files p0000.html, p0001.html, p0002.html, p0003.html, and p0004.html. Every HTML page contains part of the text typed in the textbox (according to slide subdivision policy explained in the previous section) and a reference to a common CSS file. This CSS file stores information such as the color of the background, the color and the size of the the text, and so on.

The duty of the *control-room* is to determine which slide is triggered, and notify it to the viewers. The information about the triggered (or current) slide is contained in an *integer variable*. This variable can be read and written by the control-room and can be read (and only read) by the viewers.

The *viewers*, knowing the integer value of the current slide, build the name of the corresponding HTML file (adding the prefix, some 0 digits and the extension), fetch the page and visualize it. A viewer can also fetch and visualize pages with a smaller index than the current slide (going into the *surfing* status, as explained in the previous section).

With this design, the HTML pages are stored in a single place, the information about the current slide is managed only in the control-room, and every viewer can autonomously decide to visualize either the current slide or the previous ones. The action of jumping to the current slide is performed by reading the value of the integer variable for the current slide, building the name of the HTML file, and accessing that file.

3.4 Compatibility

ICP has been build on *standard technologies* (HTML 5, CSS 3 and Javascript), *using only tags and features that are fully supported by major browsers* (e.g., Internet Explorer, Firefox, Chrome, Safari, Opera). This guarantees a high level of compatibility with all the possible devices that will use ICP. In fact, ICP works on any browser able to visualize HTML pages and run Javascript code. Any device with such a browser is able to run any ICP component, regardless of the operating

on. Changing *prefix* to 'Slide' and *extension* to '.jpg' allows to stream these files instead of HTML pages. Even if ICP works better with HTML pages, providing compatibility with PowerPoint presentations is a desirable feature.

system (MAC, PC, Linux, Android are fully compatible). The software has been successfully tested on Chrome, Internet Explorer, Edge, Safari, Firefox, and Opera, on laptops and smartphones running Windows, IOS or Android.

Moreover, the full compatibility with the web standards puts ICP in a good position for being compatible with any (even future) device. For example any wearable technology such as Apple Watch (Weber, 2015), Google Glasses (Yakob, 2012), or other devices for augmented reality, commonly support HTML, CSS and Javascript, thus being ICP compatible.

Chapter 4

Experiments: ICP for Symphonic Concerts

The ICP Software has been preliminarily tested in pilot studies, like chamber music performances, with an audience limited to 20-35 people. These tests had the main goal of tuning the technology, fixing some technical issues, and having an initial feedback on the appreciation of the software. Once the ICP technology was considered mature, a bigger experiment was set up at the University of Kansas. The purpose of the experiment was to test the ICP technology in a real concert setting, through observation of audience technology use and collection of feedback about this service, to determine if audience prefers this technology to traditional printed concert programs. The feedback, collected with an electronic questionnaire, included rating the usefulness of ICP and traditional concert programs. The analysis of variances and the paired t-test has been performed to compare the responses. The results obtained from this study indicate that the audience prefers this new technology to traditional program notes and would like to have ICP Software available in future concerts. The experiment took place in a concert hall with a real orchestra and a real audience. The concert happened on September 28^{th}, 2016, when the Kansas University Symphony Orchestra performed a symphonic concert at the Lied Center of Arts, as part of the 2016-2017 concert season.[1] Before the concert, Maestro Jung-Ho Pak, guest conductor of the orchestra, kindly agreed to try the ICP Software during the performance. The concert took place in the main auditorium, which has almost 2000 seats. The ICP software provided live textual information on the last piece of the concert, a selection from the ballet *Romeo and Juliet* by Prokofiev, including *Montagues and*

[1] The Kansas University Symphony Orchestra (KUSO) is composed of 70-80 players from the University of Kansas, who are mainly music majors from the School of Music. It performs standard symphonic repertoire, with at least three performances per semester. The Lied Center for Performing Arts is a big complex for concerts and conferences in Lawrence, KS.

Capulets, *Young Juliet*, *Masks*, *Death of Tybalt*, and *Romeo at the Juliet's Grave*. The experiment had two parts: first, the audience listened to the selection from *Romeo and Juliet*, with the option of following the live notes via the ICP Software; then, at the end of the piece, they were asked to fill out an online questionnaire on their experience with ICP.

4.1 Setting up the experiment

Participants

The participants in this study were a subset of the people attending the concert. According to the ticket office, 607 tickets were sold for the performance, and 202 people watched the concert via the live-stream platform.[2] Among all the viewers (physical attendees and on-line viewers), around 100 of them used the ICP Software, as tracked by the software connection log. Among them, 28 completed the survey. Software use and survey completion were voluntary.

Materials

A set of 88 textual slides was prepared: the first two introduced the ensemble and the piece, while the other 86 followed the music. These 86 slides addressed the plot of the pieces, the connection between the music and the plot, and the musical choices of the composer (such as musical form, instrumentation, harmonic language). The selection from *Romeo and Juliet* was 25 minutes long, thus every slide was triggered on average every 17 seconds. The questionnaire was built on the Survey Monkey website and had ten questions. The first three questions inquired about the user's background, while the other seven questions focused on the specific experience with ICP during the concert. There were three types of questions: multiple-choice questions, rating questions, and one open-ended question. In addition to the survey, some feedback was received from a post-concert email sent by the Lied Center communication office to the subscribers, as some people provided

[2]The webcast statistics of the Lied Center report 202 unique users accessing the live-stream platform in 276 viewing sessions, with an average session duration of 8 minutes and 13 seconds.

feedback on the use of ICP. Questions 3 and 5 were the key questions of this study: question 3 asked to rate the usefulness of traditional concert programs on the base of participants' past experience, while question 5 asked to rate the usefulness of the ICP Software during that performance.

Procedure

The audience entering the hall received both the traditional booklet with information about the concert as well as a piece of paper with a brief explanation of the ICP Software and the QR code containing the link to the ICP slides. Before starting the selection from *Romeo and Juliet*, the conductor introduced the technology and encouraged the audience to grab their phones, scan the QR code and follow the ICP slides while listening to the orchestra. After the last slide, the software visualized a link that directed the user to the questionnaire about the experience with ICP. A visual message thanked the user and encouraged him/her to take the questionnaire.

4.2 Results

Thanks to the ICP connection log, it was possible to know how many users were connected to the system while the slides were triggered. Figure 4.1 shows the number of active connections per slide. At the first slide (containing the ensemble's and conductor's name) the number of connections was low (only 11). After the introduction to ICP made by the conductor, the number of connections rapidly increased to 84 (for the second slide, containing the title of the piece). For the whole performance, it stayed stable on an average of 104 connections. Considering 809 persons as the overall audience (in the hall and on-line), it means that 12.8% of them used ICP throughout the whole *Romeo and Juliet* execution. Among these users, 28 filled out the questionnaire, i.e. the 26.9% of the ICP users. The questions asked in the survey and all the responses collected can be found in Appendix A.

The information gained can be categorized in users' background information, technical feedback, overall ICP experience, additional feedback.

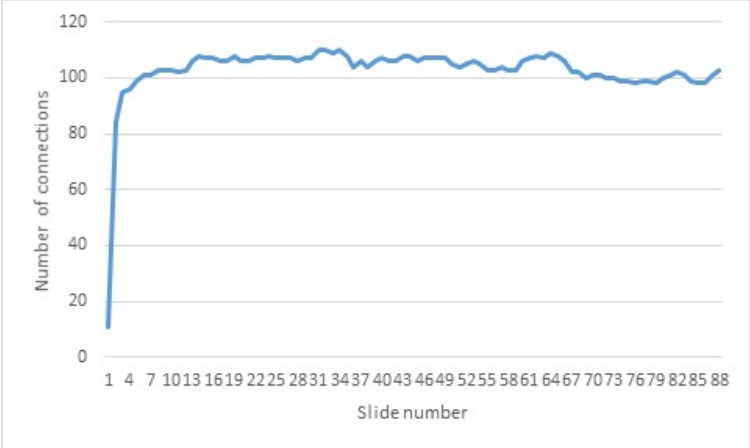

Figure 4.1: Number of connections to ICP for each slide

Users' background information

General information collected by survey questions 1, 2, and 3 indicated that the majority of the respondents (78.6%) looks for information about the music and the performers, either with personal research (10.7%), or reading the program notes provided in the hall (50%), or using both these methods (17.9%). Only a minority of them (24.4%) are not interested in getting additional information. The respondents show a general interest in reading program notes, with 89.3% of them reading program notes 'Usually' or 'Always.' When asked to rate the usefulness of traditional program notes from 0 (totally useless) to 100 (very useful), the average rate obtained was 71 (number of participants $N = 28$, mean $\overline{X} = 71.39$, standard deviation $\sigma = 26.4$). The analysis of variance showed that the answers varyed widely.

Technical feedback

Two questions were asked to obtain technical feedback on the technology used. Question 6 asked if the respondent were distracted by other people using their phones. 96.3% were 'not distracted at all', 3.7% were a 'little bit distracted', and no one (0%) was 'very distracted.' Question 7 was meant to verify if the live notes fitted the screen properly: it happened 'always' in the 39.3% of the cases and 'most of the time' in the 60.7% of the cases (other possibilities were 'occasionally', 'almost never' and 'never', which all got 0%).

Overall ICP experience

The remaining questions investigated the ICP experience. Question 4 verified that respondents followed the live notes. The 80% of the respondent followed 'all the notes', while the 12% followed 'almost all the notes' and the 8% 'some of the notes.' Question 5 asked to rate from 0 to 100 how much the live notes were useful to enjoy the concert better (0 meaning totally useless, 100 very useful). The average rate obtained was 89 ($N = 28$, $\overline{X} = 89.93$, $\sigma = 16.85$). The analysis of variance showed that the shape of the curve for this answer was more compact than the one for question 3. The test for equality of variances was performed: the F value of the two variances is 2.45, above the critical value 2.13 (two-tailed test, $\alpha = 0.05$), thus the two variances are not comparable (as we can also see from Figure 4.2). To compare the ratings between the use of traditional progam notes (group 1) and live notes (group 2) a t-test was conducted. Results showed differences between groups, where group 1 had $\overline{X} = 71.39$, $\sigma = 26.4$, and group 2 had $\overline{X} = 89.93$, $\sigma = 16.85$. The paired t-test revealed a significant statistical difference between the two groups ($\alpha = 0.05$, $t(27) = 3.67$, $p = 0.43$).

Question 8 asked to judge the overall experience with ICP, and question 9 addressed the desire to have the techonolgy available in future concerts. 96.43% of the respondents rated the ICP experience either 'Very positive' or 'Positive', and 92.85% of them answered that they would like to have this technology available in future performances either 'Always' or 'In some performace.' In the last question, respondents were free to leave any feedback on the live program notes experience. Apart from entusiastic comments (like "Excellent work!") and quick criticisms (such as "Do on projector above orchestra"), some feedback addressed very crucial issues. One participant stated that it is a great idea, but not for every concert, as "Getting lost in the music is part of the joy of a going to a concert... reading notes can prevent that escape." Someone else suggested multiple sets of live notes, to address different levels of musical background in the audience: "Maybe have two different ones going if possible. One for people with theory background to talk more about the theory based notes vs the one presented the concert hall." A few respondents showed interest in having information about "chord progression," "themes," "instruments," and "music forms." One

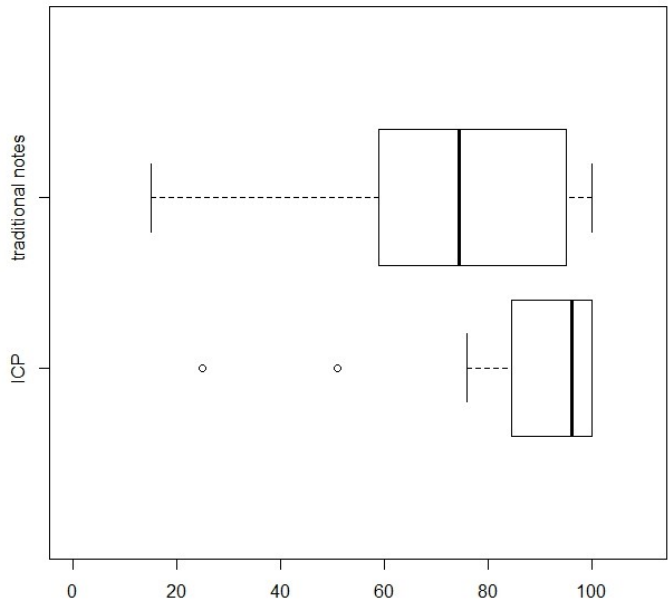

Figure 4.2: Comparison between the rates for the traditional notes and the ICP live notes

person also suggested the use of pictures in addition to plain text. All the answers to this last open question are listed in table A.4 in Appendix A.

Additional feedback

Some feedback arrived from the Lied Center in post-concert emails. Below two of them are reported, representing opposite sides of the spectrum. The first one was very critical: *"I think the idea of receiving texts during a performance is frankly, ridiculous. Before the concert suggest that attendees either read the program notes or perhaps hold a pre-conference talk. I do not enjoy being distracted by the glow. Raise up, don't dumb down. Other than that it was a most enjoyable performance."* The second one was very supportive: *"My wife and I were thrilled with the KU Orchestra program last night. It was so exciting to hear the fine musicians that KU has attracted. [. . .] My main reason for sending this note, however, is to express our appreciation of the Live Interactive Streaming during Prokofiev's* Romeo and Juliet *selection. Please let the conductor know*

of our appreciation of his including this new concert technology. I hope this experiment will be continued in future concerts."

4.3 Discussion

As this experiment did not have a controlled set of participants, we cannot state scientific conclusions from the quantitative data collected, but we can draw some meaningful considerations. First of all, the audience was interested in trying the ICP technology. From Figure 4.1 it is clear that once people started using the live notes, they remained connected for the entire performance. Second, the audience cared about the music and the performers and was familiar with the traditional program notes. This means that our respondents were appropriate to judge the new ICP Software, as they were familiar with the traditional concert programs and ICP Software represented the modern version of concert programs. It is interesting that on two similar questions (question 3 and 5) asking to rate from 0 to 100 the usefulness of traditional program notes and live notes, the ICP live notes outperformed traditional program notes, as shown in figure 4.2.

This encouraging result was confirmed by the general level of appreciation of the ICP technology, with respondents clearly giving a positive feedback for the technology and expressing the desire to have it in future concerts. One of the common criticism to this experiment was that following the notes on the phones, people might lose the connection with the music and the performers. It is a legitimate criticism that needs to be considered. First of all, it is important to ensure that people are not using the service are not distracted by other people's phones. According to the present study, the software performed well on this issue, with only 3.7% of the respondents being a little bit distracted by other phones. The part of the audience not using the phone did not participate in the survey, so we need to make sure in a future experiment that also people not using ICP will enjoy the concert without being distracted. The ideal setting that will ensure the best result will be with the use of modern devices like Google Glasses, special glasses able to projects textual information on the lenses. People wearing them and connecting them to the ICP web application could watch the performance traditionally and have ICP live notes streamed directly on

their lenses. This device would allow keeping the focus on the performer and the music, as well as receiving information without distracting other people.

Chapter 5

Applications

Improving the audience experience during *live performances* is the natural goal of the ICP software. This includes: program notes for concert halls; multi-language lyrics and texts for opera houses and theaters; description for the Deaf in theaters and movie theaters; live comments and audience interaction in any type of event, ranging from avant-guard music concerts, to improvised theatrical plays. It is important to notice that ICP also works well with performances that are web-streamed; anyone with the address of the ICP notes can receive the slides, even if not physically present in the theater.

ICP can also be a very powerful *educational tool*. As a presentation tool, it could be used during a lecture to simultaneously stream the slides on a projector and on the participants' devices, with the additional possibility of navigating the slides, zooming the images, browsing the web, and so on. Moreover, ICP allows streaming the presentation to participants not in the room, providing an easy tool for online classes or video conferences, where students or participants are spread in different places. One key characteristic of ICP presentations is that there is no limit on the audience dimension and location, allowing the presenter to provide live notes for worldwide live events. Consider a music concert which is broadcasted on TV in different states or countries; a musicologist could prepare live notes for this performance, share the ICP address of the presentation, and reach all the people that are watching the concert on TV.

Of course, the use of ICP will be more natural and smooth as *wearable technology* will become available. With the right glasses or headsets, people could read the ICP notes without any need to look down to a screen. Google Glasses-like devices will probably be the best device for using ICP: Yakob (2012), analyzing the potential applications of these glasses, reported that they could make

"mainstream theater accessible to people who are deaf or hard of hearing by providing real-time subtitles through the display."

In a broader perspective, ICP can address an extended concept of augmented reality, which we may call *augmented performance*. Augmented reality provides additional information about the world that surrounds us, according to where we move in the space; similarly, augmented performance provides additional information about the imaginative world we hear/see on stage, according to the progression of the timeline of the live performance.

Chapter 6

Future Works

In order to improve the ICP technology, two main tracks of development are necessary: 1) adding functionality to the ICP software, and 2) testing the software in real settings, setting up both controlled and noncontrolled experiments.

6.1 Adding functionality to ICP

The following features will be added to ICP and will improve the interactive experience during live performances.

- *Multi-language support*: each slide could embed the same information in several languages. ICP could detect the language of the device, or ask the users' preferred language, and trigger the text accordingly.

- *Adaptive slides*: each user could choose between different sets of slides, according to his/her musical background and the type of information he/she would prefer to get during the concert.

- *Slide templates*: some templates could be added in the *editor* component to facilitate the creation of slides containing both text and images.

- *Transition effects*: the transition from one slide to another (i.e., the way the old text disappears and the new text appears on the screen) could be performed in many ways. The editing process of the slides could offer several transition options.

- *Saving/sharing buttons*: when navigating the ICP slides, the user will have the possibility of saving/sharing a single slide or the entire presentation. These options can include: saving on a device or cloud, sending as an email or message, sharing on social media, such as Facebook, Twitter or Google+.

- *Real-time pool*: some slides could incorporate questions to the users. In this way, during a concert, the performers could have immediate feedback from the audience that could drive the live performance.

- *Users' profiles*: every user, either an ICP *viewer* or an ICP *provider*, could set up his/her profile and interact with other users. Providers could advertise upcoming performances which will feature ICP notes, trying to reach new viewers. Viewers could subscribe to providers to receive notifications about upcoming interactive events, rate the service, and give feedback. Viewers could share preferences and interests with other viewers or providers.

All these functionalities can be easily added, as the ICP software is based on web technologies, such as HTML, CSS, and Javascript, which are already able to manage these concepts.

6.2 More experiments

The case study reported in section 4 showed interest and appreciation on live notes during a symphonic concert, but a controlled experiment seems necessary to assess the effectiveness of this new technology scientifically. It would be ideal to perform a two-group pretest-posttest analysis, to compare traditional program notes and live notes on two factors: 1) the level of enjoyment of the performance; 2) the amount of information that people remember after the concert. A set of participants would be randomly selected and divided into two groups (group A and B). All participants would attend the same concert, with group A receiving information about the music and performers via traditional program notes, while group B would receive the same information via live notes on their phones. Questions about the appreciation of the concert will be asked to all participants at the end of the performance. Questions certifying the participants' knowledge about the music

and the performers would be asked before the concert (thus, before giving them program notes or live notes) and after the concert. This experiment should clearly determine if the ICP live notes are more effective than traditional program notes. Future experiments also need to measure the following aspects: disturbance on other audience members (both using and not using ICP); number of actions performed by the users on the viewer component (i.e., backward, forward, click-on-link, go-to-the-current-slide); time spent on each slide.

In addition to a proper controlled experiment like the one described above, several noncontrolled experiments have been performed, using ICP during concerts at the School of Music of the University of Kansas. These experiments include: providing program notes for the concert of the Ensemble Improptu Percussion Quartet (January 18th, 2017); providing a real-time full translation of *Carmina Burana* by Carl Orff, performed by KUSO and KU Choirs (February 18th, 2017); accompanying the presentation by astrophysicist Gregory Rudnick on the Hubble telescope at the Lied Center (April 18th, 2017); providing program notes for the KUSO concert including Tchaikovsky *Violin Concerto* and Dvorak *Symphony No. 8* (September 28th, 2017); accompanying the execution of Strauss *Death and Transfiguration* with the poem related to the composition (November 6th 2017); providing commentary and images to the execution of Mussorsky *Pictures at and Exhibition* (March 15th, 2018). These experiments have helped adjusting the technology and its new features, and have provided informal feedback from a wide range of users.

ICP has be also adopted in the recent KUSO concert on May 1st, 2018 and in the Philharmonia of Greater Kansas City concert on May 6th, 2018.

Chapter 7

Conclusion

Noting the desire for new ways to engage the audience in the performing arts, the present work uses new technologies as a powerful tool for helping people in better understanding and appreciating live performances, and provides a new tool to adi organizations in theirs efforts to better engage their audiences.[1] The long term goal is to strengthen interest in performing arts. To this aim, the Interactive Concert Programs software has been developed, a web application that can be easily used in any performative setting to provide live and interactive information on the audience's devices. ICP follows principles of simplicity, usability, effectiveness and cheapness. An experiment performed at the University of Kansas during a symphonic concert with a real audience collected feedback from the people using the software. The results of the experiment clearly showed that the software is effective, that it was well received and that people want to see this technology used in future concerts. Using web technologies already available, the software can be enriched with new features that would make it more interactive and easy to use. Lastly, ICP is compatible with any device supporting HTML and Javascript browsers, including wearable technology not yet released (e.g., Google Glasses).

The experiment performed with ICP also underlined possible disadvantages on its use that should be carefully taken into consideration. First of all, it is important *not to overwhelm the audience* with too much information. The ICP slides should be designed with a right balance between adding meaningful information and letting the audience enjoying the performance freely. An average of a slide every 17 seconds (86 slides for 25 minutes of music) seemed a good compromise in

[1] In the past decade, the League of American Orchestras has focused the effort of its *Kwnoledge, Research and Innovation* research branch on audience engagement, suggesting strategies to address this matter. Additional information can be found on their website (see League of American Orchestras, 2018).

the experiment, but the rhythm of the slides should be decided on a case by cases basis: the type of concert and audience, as well as the type of learning/entertaining experience desired for that performance should be considered.

It is also not effective that ICP provide *textual information simultaneously to other textual or oral information* delivered from the stage (spoken or sung). This is acceptable (and encouraged) if the ICP slides reinforce the live performance, for example with translations or short summaries of the speech. The human brain can easily follow only one text at the time (written or spoken): thus, having to focus on different information from the stage and from the slides will likely result only in confusing the audience. A successful approach would be using text on ICP when the live event provides images/sound and using images/links on ICP when the live event provides text or speech.

More generally, it is important to determine in which performances it is appropriate to use this technology. For example, many concert goers worship the experience of a live concert as a moment of pure art, where nothing else than the music should matter. The use of technology in a concert hall might be seen as a despicable intrusion in a sanctuary of the art. For this reason, special occasions like opening nights and premieres could preserve the purity of the concert experience, without allowing the use of technology. Similarly, technology could be banned from being used in the central (and most expensive) seats of a concert hall (e.g., orchestra or parterre seats), which are usually taken by authorities and old-fashioned subscribers.

However, even recognizing the needs of the conservative segments of an audience, ICP technology can be successfully exploited in several situations. For examples, theaters could reserve *interactive-friendly seating* for people that want to receive ICP information, without disturbing other people. Moreover, a concert season could schedule specific *learning nights*, (such as open dress rehearsals or closing nights), where the audience is allowed or even encouraged to use the devices for receiving live information via ICP. As an audience is made of people with different backgrounds, needs and expectations, it is always better to give them different modalities to enjoy a performance, and let them choose in which way they want to experience the concert. In the future, with wearable technology like Google Glasses, ICP can be used without our seat neighbor

noticing it.

Of course, avant-garde concerts, performances in foreign languages and learning-oriented events will naturally benefit from the ICP software. This new technology will help the audience understanding and appreciating performing arts, engaging their curiosity and interaction. An entertainment setting like a live performance could easily become a friendly learning environment, leading to an *Edutainment* activity.[2] In this context, new layers of information will be delivered on top of the entertaining experience and will be hopefully understood and memorized more effectively.

ICP software can be used by anyone, as it does not require any coding skill or HTML knowledge in order to create and run the slides. A massive use of ICP can actually mitigate the editing process of printed concert programs, saving time, money and trees. Ideally, in the future, every concert hall will adopt the ICP technology and hire a musicologist. He/she would have the responsibility to tailor ICP notes for every concert, according to the specific event, the audience, and the type of entertaining/learning path that has been designed for that specific season or concert cycle.

The performing arts are going through a moment of crisis and demand new ideas to engage audiences, bring people to the theaters, and connect people with the artists and their artworks. ICP is a modern tool that anyone can easily access, and if broadly used, can give a substantial contribution to these goals.

[2]The term *Edutainment* originated in the 1970s, blending the words 'entertainment' and 'education'. According to the Merriam-Webster dictionary, it refers to 'entertainment that is designed to be educational.'

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Appendix A

Survey - Questions and Responses

Question 1: Before going to a concert, do you look for information about the music and the performers? How?

◦ No

◦ Yes, doing some personal research (books, websites)

◦ Yes, reading program notes provided in the concert hall

◦ Yes, both doing personal research and reading program notes

Question 2: When you go to a concert, how often do you read program notes?

◦ Never

◦ Rarely

◦ Sometimes

◦ Usually

◦ Always

Question 3: Do you usually find printed programs notes useful?

(totally useless) 0 ——————————— 100 (very useful)

Table A.1: Responses to questions 1, 2, 3

Respondent	**Q1**	**Q2**	**Q3**
1	Yes, doing some personal research (books, websites)	Always	100
2	Yes, both doing personal research and reading program notes	Always	90
3	No	Always	70
4	Yes, both doing personal research and reading program notes	Always	58
5	Yes, reading program notes provided in the concert hall	Sometimes	31
6	Yes, doing some personal research (books, websites)	Always	100
7	Yes, reading program notes provided in the concert hall	Usually	39
8	No	Sometimes	20
9	No	Usually	71
10	Yes, reading program notes provided in the concert hall	Always	80
11	No	Usually	30
12	Yes, reading program notes provided in the concert hall	Usually	100
13	No	Always	60
14	Yes, reading program notes provided in the concert hall	Always	100
15	Yes, reading program notes provided in the concert hall	Usually	90
16	Yes, reading program notes provided in the concert hall	Usually	100
17	Yes, reading program notes provided in the concert hall	Usually	84
18	Yes, reading program notes provided in the concert hall	Always	90
19	No	Rarely	15
20	Yes, reading program notes provided in the concert hall	Usually	66
21	Yes, reading program notes provided in the concert hall	Usually	100
22	Yes, reading program notes provided in the concert hall	Usually	78
23	Yes, reading program notes provided in the concert hall	Always	70
24	Yes, doing some personal research (books, websites)	Usually	41
25	Yes, both doing personal research and reading program notes	Usually	70
26	Yes, both doing personal research and reading program notes	Usually	100
27	Yes, both doing personal research and reading program notes	Always	61
28	Yes, reading program notes provided in the concert hall	Usually	85

Question 4: During the September 30th concert, how much of the live notes on your phone about the Prokofiev did you followed?

◦ Nothing

◦ Just a little bit

◦ Some notes

◦ Almost all of them

◦ All the notes

Question 5: Were the live notes on your phone useful to better enjoy the show tonight?

(totally useless) 0 ——————————— 100 (very useful)

Table A.2: Responses to questions 4,5

Respondent	**Q4**	**Q5**
1	All the notes	100
2	All the notes	85
3	All the notes	100
4	All the notes	100
5	All the notes	100
6	(skipped)	99
7	All the notes	100
8	All the notes	84
9	All the notes	83
10	All the notes	100
11	All the notes	99
12	All the notes	100
13	All the notes	100
14	All the notes	100
15	All the notes	94
16	All the notes	100
17	All the notes	98
18	Almost all of them	86
19	Some notes	25
20	All the notes	85
21	All the notes	100
22	All the notes	89
23	Almost all of them	51
24	Some notes	76
25	(skipped)	89
26	Almost all of them	77
27	(skipped)	80
28	All the notes	90

Question 6: Were you distracted by people around you using their phones for the live notes?

○ Very distracted

○ A little bit distracted

○ Not at all distracted

Question 7: How often did the live notes fit the screen of your device properly?

○ Always

○ Most of the times

○ Occasionally

○ Almost never

○ Never

Question 8: How would you rate the experience with "Interactive Concert Programs" tonight?

○ Very annoying

○ Annoying

○ Indifferent

○ Positive

○ Very positive

Question 9: Would you like to have Interactive Concert Programs in future performances?

○ No, never

○ Maybe sometimes

○ Indifferent

○ Yes, in some performance

○ Yes, always

Table A.3: Responses to questions 6,7,8,9

Respondent	**Q6**	**Q7**	**Q8**	**Q9**
1	Not at all distracted	Always	Very positive	Yes, always
2	(skipped)	Always	Very positive	Yes, in some performance
3	Not at all distracted	Most of the times	Very positive	Yes, always
4	Not at all distracted	Always	Very positive	Yes, always
5	Not at all distracted	Most of the times	Very positive	Yes, always
6	Not at all distracted	Always	Very positive	Yes, always
7	Not at all distracted	Most of the times	Very positive	Yes, always
8	Not at all distracted	Most of the times	Positive	Yes, in some performance
9	A little bit distracted	Most of the times	Very positive	Yes, always
10	Not at all distracted	Always	Very positive	Yes, always
11	Not at all distracted	Most of the times	Very positive	Yes, in some performance
12	Not at all distracted	Always	Very positive	Yes, always
13	Not at all distracted	Always	Very positive	Yes, always
14	Not at all distracted	Always	Very positive	Yes, always
15	Not at all distracted	Most of the times	Positive	Yes, in some performance
16	Not at all distracted	Most of the times	Very positive	Yes, always
17	Not at all distracted	Always	Very positive	Yes, always
18	Not at all distracted	Always	Very positive	Yes, always
19	Not at all distracted	Most of the times	Indifferent	Indifferent
20	Not at all distracted	Most of the times	Very positive	Yes, in some performance
21	Not at all distracted	Most of the times	Very positive	Yes, always
22	Not at all distracted	Most of the times	Very positive	Yes, in some performance
23	Not at all distracted	Most of the times	Positive	Maybe sometimes
24	Not at all distracted	Always	Positive	Yes, always
25	Not at all distracted	Most of the times	Very positive	Yes, always
26	Not at all distracted	Most of the times	Positive	Yes, in some performance
27	Not at all distracted	Most of the times	Positive	Yes, in some performance
28	Not at all distracted	Most of the times	Positive	Yes, in some performance

Question 10: Do you have any suggestion/comment about how live program notes should be?

Table A.4: Responses to question 10

Respondent	Q10
1	Excellent work
2	(skipped)
3	They were awesome! Please do this always! I've never listened so closely to the orchestra before.
4	(skipped)
5	(skipped)
6	(skipped)
7	(skipped)
8	Pictures would be interesting. It also would be great at concerts for students to see the instrument playing
9	(skipped)
10	Awesome!
11	Do on projector above orchestra
12	I really liked, enjoyed and understood better the music that was being played.
13	(skipped)
14	(skipped)
15	(skipped)
16	(skipped)
17	Particularly helpful for a concert that has a clear story. Loved it!
18	Might be harder to do when the piece doesn't tell a story but I liked pointing out themes and instruments and music forms (ex rondo)
19	(skipped)
20	(skipped)
21	(skipped)
22	(skipped)
23	(skipped)
24	(skipped)
25	(skipped)
26	Maybe have two different one going if possible. One for people with theory back ground to talk more about the theory based notes vs the one presented the concert hall. It would be really interesting to know how the chord progression or different key is used to portray different part of the music
27	(skipped)
28	I thought it was great, but I wouldn't want to have notes every time. Getting lost in the music is part of the joy of a going to a concert ... reading notes can prevent that escape.