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An Open and Multi-Layer Web Platform for Higher Music Education

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Abstract

This paper describes an open platform for the advanced experience of music information. Based on the IEEE 1599 standard, such an environment supports an integrated and synchronized multi-layer description of music pieces. This approach can be particularly suitable in higher music education, where the structured organization of a multiplicity of free resources can foster advanced and engaging learning activities. After addressing the subject of openness in music education and introducing the key features of the IEEE 1599 format, some clarifying examples and educational scenarios will be discussed.

KEYWORDS: Music Higher Education, Web, Multi-Layer Description, IEEE 1599

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1. Introduction

The adjective "open" implies the ideas of flexibility, freedom, and welcome, in opposition to "closed", that recalls the concepts of limitation, restriction, prejudice. Such a qualifier refers to the elimination of barriers that can preclude both opportunities and recognition for participation.

When applied to education, openness has a deep impact on space, time, and processes (Blessinger & Bliss, 2016) of learning activities. Regarding the spatial dimension, open education lets people access and participate regardless of their physical/geographic location; concerning the temporal dimension, it supports asynchronous forms of communication and participation, unlike traditional formal models. At present, open learning experiences are strongly linked to digital technologies (e.g., computers, mobile devices, network infrastructures, etc.), since space and time limitations can be easily removed by making educational materials available online. Nevertheless, open education has a number of implications that go far beyond mere online sharing, rather asking to rethink processes, too: only learning tools based on valid design principles, reliable teaching methods, and well-established learning theories can achieve the pedagogical results expected from open education.

The basic idea is to democratize learning and training activities, bringing them outside formal education systems and places, such as schools, universities, and academies. Since the focus is on autonomous learning, it is crucial to provide learners with suitable content and tools. In the digital era, open initiatives can rely on a technological infrastructure able to access and integrate heterogeneous information, possibly in a highly-customizable environment able to adapt to users' needs.

The rest of the paper is organized as follows: Section 2 will provide some key references from scientific literature to better understand the fundamentals of open education in the digital era; Section 3 will focus on open approaches in higher music education; Section 4 will introduce the so-called IEEE 1599 ecosystem, that includes an international standard for the multi-layer description of music content, a suite of applications to produce materials in this format (not treated in this paper), and a web platform to enjoy IEEE 1599 documents, thus constituting the theoretical and technological basis for our proposal; Section 5 will present two higher-education scenarios dealing with music learning and practicing; finally, Section 6 will draw the conclusions.

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2. Related Works

The key concepts of technology-enhanced open education have been discussed in a number of scientific works, such as (Seely Brown & Adler, 2008; Iiyoshi & Kumar, 2010; Llorens et al., 2014), to mention but a few. In general terms, they focus on the design and release of open educational resources on one side, and on the technological infrastructure required to support learning activities on the other. Both aspects are relevant in our proposal, and they will be discussed separately in Sections 4 and 5.

Concerning *open educational resources* (OER), the final report of the 2002 UNESCO forum on higher education defined them as "digitized educational materials and tools freely offered for educators, students and self-learners to use and reuse for the purposes of teaching, learning, and research" (UNESCO, 2002). Other commonly accepted definitions emphasize practical rather than theoretical features. For instance, Wiley (2000) considers open educational content and resources as digital learning objects that can be reused a number of times in different learning contexts, deliverable over the Internet, accessible by any number of people, also simultaneously, in opposition to traditional instructional media which can only exist in one place at a time. Other definitions of open content have been provided, but, in general, all of them converge as it regards some key features: open content is used for educational purposes, is usually free, and is available in a managed collection of learning resources via the Web.

Please note that free and unfettered access to a resource is a necessary but not sufficient condition to determine whether or not an item can be considered open. In addition, the use of such a resource should be governed by D. Wiley's 5 Rs:

- *Retain* – the right to make, own, and control copies of the content;
- *Reuse* – the right to use the content in a wide range of ways;
- *Revise* – the right to adapt, adjust, modify, or alter the content itself;
- *Remix* – the right to combine the original or revised content with other open content to create something new;
- *Redistribute* – the right to share copies of the original content, personal revisions, or remixes with others.

As it regards higher education, which is the focus of this work, openness is often associated with *Massive Open Online Courses* (MOOCs). Also in this case, the scientific literature is very rich. For example, Yuan & Powell (2013) start from current UK policies to analyze issues, challenges and implications of MOOCs; Jansen et al. (2015) broaden the perspective to the European level; Stracke (2017) investigates how to improve the design of open education and online courses; finally, Wiley (2015) makes a critical analysis of MOOCs in the context of open education, reporting some misconceptions and drawbacks. Even if MOOCs are coherent and well-organized collections of open items, openness in higher education can be implemented also in other ways, as we will discuss in the next section.

3. Openness in Music Higher Education

Music education is a very articulated field that embraces a number of heterogeneous activities, ranging from instrumental practice to theoretical subjects, and presents different goals, including the acquisition of instrumental or analytical skills and the development of creativity and expressiveness. The present work narrows it down to open experiences in music higher education.

As mentioned in Section 2, openness in higher education immediately recalls the educational model of MOOCs. Important institutions regularly release and update music-oriented MOOCs, thus enabling Web users to access them, or a part of them, for free. For instance, Berklee College of Music offers more than 40 MOOCs, available on different platforms (*Coursera*, *edX*, and *Kadenze*) and in different languages (English, Spanish, and Portuguese). These courses cover a wide range of subjects, dealing with music technology, music theory and harmony, ear training, music business and entrepreneurship, music therapy, performance and improvisation, songwriting. Many other examples could be mentioned, usually rooted in academia (e.g., Harvard University, Massachusetts Institute of Technology, National University of Singapore, University of Edinburgh, Yale University). For more details on the subject of music learning with MOOCs, please refer to (Steels, 2015).

However, openness in music higher education is not limited to MOOCs: there are also collections of high-quality digital resources available for free over the Web. An example is the *International Music Score Library Project* (IMSLP), also known as the *Petrucci Music Library*,[2] which was first released in 2006 as a virtual library of public-domain music scores, mainly old musical editions out of copyright. At present, the platform also admits scores by contemporary composers who wish to share their music by releasing it under a Creative Commons license. Moreover, it offers public-domain recordings, MIDI files, and score transcriptions. The relevance of IMSLP in the field of music higher education is certified by the high number of academic partnerships; for example, the Massachusetts Institute of Technology uses its content extensively for providing scores for its *OpenCourseWare* courses. Concerning other initiatives similar to IMSLP, it is worth mentioning the media collections of the *Internet Archive* digital library; for example, its Audio Archive includes more than 200,000 free digital recordings. Finally, recent

[2] https://imslp.org/

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digitization campaigns and the current trend to share materials over the Web are encouraging the birth of specific projects also useful for music learning and teaching, such as the *Bach Digital* initiative by Leipzig Bach Archive [3] and the digital collection of the Beethoven-Haus Bonn web site. [4]

The availability of open and high-quality materials for music education is only the first step. The success of technology-enhanced educational activities requires also the adoption of smart learning environments. *Smart pedagogy* can be defined as an educational approach based on technologically-augmented systems (Daniela, 2019). As demonstrated by a number of successful experiences (e.g., Baker, 2007; Luo et al., 2018; Avanzini et al., 2020), smart pedagogy can be profitably applied to music education. In this kind of approaches, technologically-enhanced devices clearly play a key role, but they should be as transparent as possible to the user: technology should only provide support tools to acquire skills and competences in a more intuitive, engaging and effective way.

Our proposal, discussed in next sections, is based on the two pillars of openness and smart education, and specifically addresses remote music teaching, learning, and practicing. This field is particularly challenging for the experimentation of digital technologies, even more so in the context of higher education. In institutions such as music academies, universities and conservatories, the requirements to meet in order to guarantee quality education are demanding, e.g., in terms of sound fidelity, low latency, number of media streams to be combined and precisely synchronized; events such as the loss of packets, perceivable delays, high compression of media streams – commonly accepted in a best-effort network communication, such as in videoconferencing – would not be tolerated.

During an instrument lesson or a ballet class, a typical scenario is the continuous interaction between teacher and student in a multi-modal environment, with an active and plural exchange of information. Similarly, when making music together, all musicians in an ensemble give their own contribution following the indications of the teacher/conductor and listening each other in real time, thus collectively influencing the final result. The mentioned scenarios, that are routine activities for in-presence education, in distance education can pose critical problems.

4. IEEE 1599: A Multi-Layer Educational Environment for Music

In this section, we will introduce the key concepts of the IEEE 1599 format. IEEE 1599 is an international standard explicitly conceived for the multi-layer representation of music in the digital domain. Mentioned in more than 60 scientific works,[5] mainly belonging to the area of sound and music computing, such a format is well documented in scientific literature and described in detail in the official specifications retrievable from the IEEE web site.[6] Its applicability to the field of music education has been already explored in other works, such as (Baratè & Ludovico, 2012) and, more recently, (Baratè et al., 2020), but never in an open perspective nor in the context of higher education.

The goal of this paper is to show on one side how IEEE 1599 can support the creation of open and high-quality educational resources (the content), and on the other side how already-available Web applications experienced via high-speed networks can provide a suitable learning platform (the technological infrastructure). Together, these two aspects constitute the IEEE 1599 ecosystem.

4.1 Key Features of the IEEE 1599 Standard

IEEE 1599 is an XML-based format whose goal is to provide a comprehensive representation of the information related to a music piece. To this goal, an IEEE 1599 document presents a multi-layer structure composed by 6 layers. The main feature of IEEE 1599 is the possibility to embed within a unique XML document all the materials related to a given music piece, including its symbolic score (logic layer), metadata (general layer), graphical score versions (notational layer), audio recordings (audio layer), computer-driven performances (performance layer), and relationships among musical entities (structural layer). All layers can host multiple representations, e.g., many audio tracks or score editions for the same piece. Heterogeneous information is not only collected within a unique document, but also interconnected, with synchronization among all time-based materials and links from/to the corresponding graphical content. Score to audio alignment is one of the most typical functions implemented by an IEEE 1599-based tool; other common scenarios include the interactive experience of music content and on-the-fly comparison of different sources.

The granularity of the description (i.e. the identified music events) can be fine-tuned depending on the user's needs, ranging from single score symbols (e.g., notes and rests) to aggregations (e.g., measures or even whole sections of the piece).

IEEE 1599 finds application in different categories of music software: digital score editors, optical music recognition systems, web and mobile apps, musical databases and archives, and musicology-oriented applications. For a comprehensive overview of the format, that would be beyond the scope of this work, please refer to (Baggi & Haus, 2013).

[3] https://www.bach-digital.de/
[4] https://www.beethoven.de/en/archive/list
[5] https://ieee1599.lim.di.unimi.it/documentation_papers.php
[6] https://standards.ieee.org/project/1599.html

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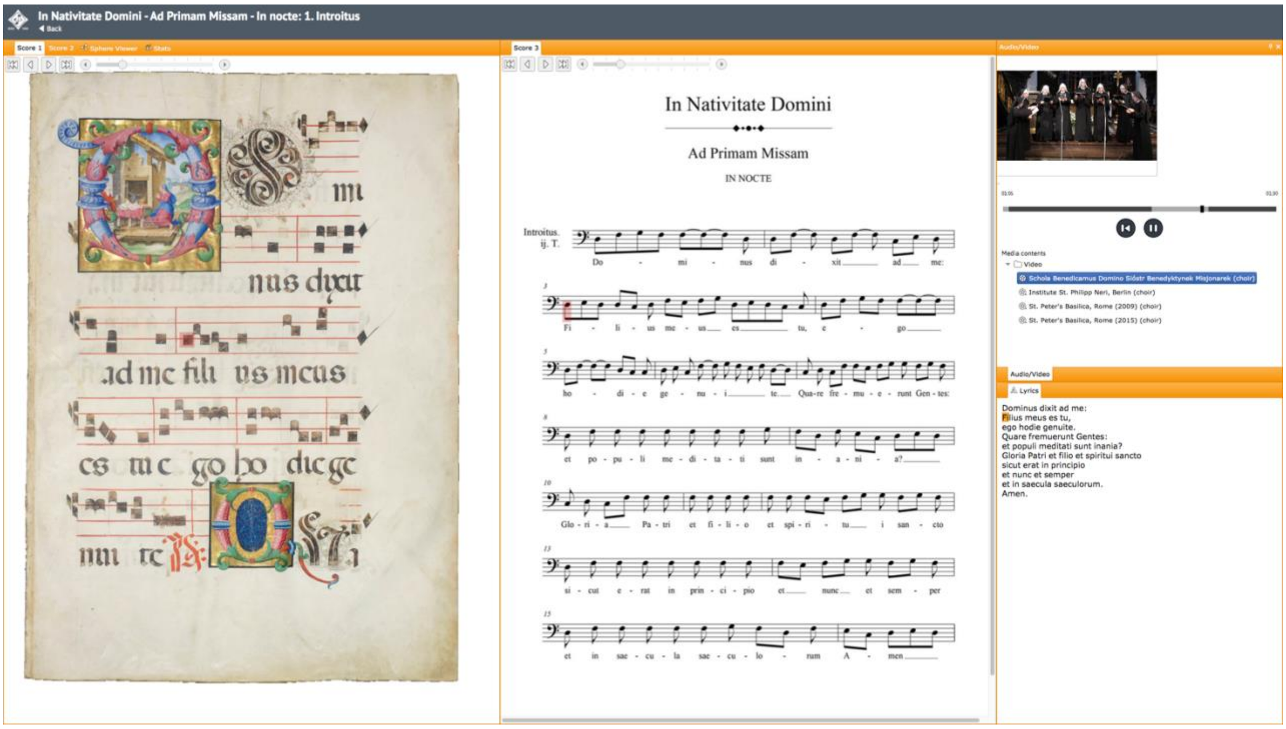

Figure 1 - The graphical user interface of the *IEEE 1599 Web Player*. Two side-by-side panels in the main area show different score versions, while the right column contains a media player, a list of audio/video materials and the lyrics panel. Multiple cursors, colored in red and orange for scores and lyrics respectively, highlight the elements being played.

4.2 Research Method

Before describing the web interface to enjoy IEEE 1599 documents, it is worth providing some details about the research processes that led to the realization of such an environment.

The official origin of the IEEE 1599 initiative dates back to 1992, when the IEEE Computer Society Task Force on Computer Generated Music was established. Several intermediate milestones – including the constitution of the IEEE Technical Committee on Computer Generated Music (1994), the creation of the IEEE Standards Association Working Group on Music Application of XML (2001), the organization of an international symposium (2002) – led to the approval of the IEEE 1599 standard, occurred in 2008. All these steps involved scholars and experts in the field of sound and music computing, coming from both academia and industry. Their different background, expertise, and vision influenced the development process.

The original goal of the format (and of the applications built on it) was the release of novel multimedia products supporting rich and advanced experience of music through user-friendly interaction. Some experimental prototypes, presented at conferences and stakeholders mainly as a proof of concept, went in that direction, thus originating the later development of a class of applications for a general-purpose audience. The first examples were off-line software programs running on local computers.

The educational purpose, in the developers' early vision, was only a side effect of the adopted model: even a user with no music knowledge could enjoy and interact with the synchronized presentation of notation and audio, so as to learn something from the experience in a non-formal and non-mediated way. Examples include a number of IEEE 1599-based products released for exhibitions and multimedia installations.

The explicit applicability of such an approach to educational scenarios emerged later, when scholars with a pedagogical background noticed the potential of the IEEE 1599 format in school and higher education. Consequently, a spin-off of the project focused on software applications conceived for music teaching and learning. Such an activity culminated in the release of support material in IEEE 1599 format to be attached to textbooks edited by Pearson (2014).

In parallel, technological evolution has pushed the development team to investigate more and more the potential of web applications, so as to extend the audience and release cross-platform solutions.

Finally, also the authoring tools to produce IEEE 1599 documents have evolved over time. At the beginning, the approach was to write XML code by hand, with no support tools, and even synchronization cues in graphical and audio files were determined through manual operations. Of course, the process was very time-consuming and the final encoding presented many mistakes. The following evolution, achieved as soon as the format became a standard, was the development of

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software plugins to export notation (and other available information) from score editors commonly in use, such as *MakeMusic Finale* and *MuseScore*. In the meanwhile, a number of computer-aided tools to improve synchronization was released. In this sense, a milestone was the development of the *IEEE 1599 Framework* for Microsoft Windows, later reimplemented in Java so as to foster cross-platform compatibility. Current efforts are aiming to port such an authoring platform into a web environment, whereas the web player described in Section 4.3 is already available.

It is worth remarking that the design and development of educational experiences based on IEEE 1599 was not a linear process, since hundreds of contributors with heterogeneous skills and competences have been involved at different stages, and the research effort in this direction is still ongoing.

4.3 The Web Interface

A core application for online experience of IEEE 1599 documents is the *IEEE 1599 Web Player*, whose synchronization engine was first released in 2011 and is constantly updated. The most recent release is publicly available in the "Music Archive" area of the IEEE 1599 web portal,[7] which also collects a number of clarifying examples (see Section 4.4).

The graphical user interface is shown in Figure 1. The main area lets the user watch graphical content. Scores and alternative symbolic representations (e.g., lyrics, Petri nets, and additional notational representations, when available), they can be opened in multiple tabs. For example, it is possible to watch multiple score versions simultaneously. To do that, drag the label on top of the panel to move, and release it in one of the allowed locations (top, bottom, left, right, center).

In the right column, all audio and video materials are listed; in the top area, there is a media player with common controls.

The basic functions provided by the player are:

- Score following - When the user clicks the "Play" button, music starts and multiple cursors over the graphical representation of the score move so as to highlight the chords and rests currently playing;
- Synchronization - All media (e.g., scanned scores, audio tracks, transcribed lyrics, and video contents) are mutually synchronized: the user can switch among them in real time, even while music is playing. In the case of audio/video content, only one media can be selected at a time, and the new selection will automatically discard the media currently playing.
- Interaction with music content - The IEEE 1599 viewer provides multiple ways to interact with music content in order to change the current playback timing. In particular, some areas in the score representations are sensitive to mouse click (a typical example is the bounding box around chords and rests, which can be clicked). Other representations allow this kind of interaction, e.g., lyrics and Petri nets diagrams (when available) are clickable and present a similar behavior.

Among advanced features, particularly relevant for educational purposes, it is worth mentioning diagrams and statistics and automatically-computed graphical representations. The Stats tab contains diagrams with the results of musicological and mathematical analyses conducted on the original XML files. Examples include the distributions of pitch classes, rhythmical values, and MIDI pitches. Alternative graphical representations are computed starting from the information in the logic layer of the IEEE 1599 document. An example is the Sphere Viewer, that shows notes and rests as spheres, horizontally spaced according to the position in measure, vertically placed according to pitch, sized on the base of rhythmical values, and colored differently based on the part and voice.

4.4 Examples

The list of music pieces publicly available in the Web repository, under the Music Archive area, is constantly updated. Please note that the goal of the platform is not to provide a comprehensive corpus of documents concerning an author, a genre, a historical period, etc.; this kind of activities is addressed by specific applications that can been realized and released through the IEEE 1599 ecosystem (some examples will be introduced in the following). Rather, the objective is to showcase the potential of the format. For this reason, the available examples are very heterogeneous.

The possibility to compare many different audio performances is well illustrated by Reynaldo Hahn's "A Chloris", in origin a romance for voice and piano. At the moment of writing, the corresponding IEEE 1599 document embeds 10 audio and 5 video tracks, performed by different types of voice (soprano, mezzosoprano, tenor, countertenor) and accompanying instruments (piano, harp, wind ensemble, symphonic orchestra).

The possibility to compare different score versions is emphasized by Giovanni Paisiello's "Il mio ben quando verrà", an operatic aria excerpted from *Nina, ossia la pazza per amore*. Four scores are available, including the autograph, a historical handwritten version, a reduction for voice and piano, and an old printed libretto.

Concerning music notation, the potential of the IEEE 1599 format goes beyond so-called Common Western Notation (CWN). In this sense, clarifying examples are:

- the "Introitus" from *In Nativitate Domini, Ad Primam Missam*, that includes two neumatic scores together with a modern transcription;
- the "Prèlude" from *Suite n.3* by Silvius Leopold Weiss, that provides an example of tablature for lute;

[7] https://ieee1599.lim.di.unimi.it/

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- "Pas de six: Variation III (Falling crumbs)" from *The Sleeping Beauty* by Pëtr Il'ič Čajkovskij, that presents not only the full score and a piano reduction, but also a Labanotation version, namely a system for recording and analyzing human movement commonly in use in dance;
- "Music for khomus", that demonstrates the applicability of the format to the notation for ethnic musical instruments.

All the mentioned examples can find suitable application in higher education. The possibility to watch and listen to a music piece within an integrated environment is fundamental to train ensemble-score reading, which is a curricular subject in conservatories. The option to select and compare in real time different performances is useful to improve instrumental, singing or conducting skills, thanks to the confrontation with great artists or professional performers. The support offered to multiple scores, and specifically non-CWN notation possibly aligned with its CWN counterpart, finds application in curricular subjects such as ancient music and ethnomusicology.

5. Case Studies

In this section, the characteristics of the IEEE 1599 ecosystem are applied to two scenarios typical of music higher education: musicology-oriented applications and ensemble-music experiences. Please note that openness in distance education and remote participation in music activities are issues particularly relevant in this period of forced isolation due to Covid-19.

5.1 Musicology-Oriented Applications

As mentioned above, the IEEE 1599 format has been conceived to allow on-the-fly comparison between different versions of the graphical and audio content referable to the same piece. Focusing on scores, the learner can easily trace author's revisions, differences among score editions, and so on. The possibility to jump from a material to another in real time and to support in-depth analyses and explanations via additional media (e.g., while listening to audio performances or watching video recordings) make this kind of learning activities more effective and engaging. Similarly, audio performances can be switched and compared on the fly, e.g., to investigate the evolution of interpretative models or recording techniques. In this case, the function of score following, namely the synchronization between audio and music notation, can greatly help learning. On the base of these characteristics, the IEEE 1599 format has been employed in lectures and conferences in order to support and clarify musicology observations. An evidence of this in scientific literature can be retrieved from (Dalmonte, 2008).

A different category of didactic experiences potentially enhanced by IEEE 1599 concerns computational musicology, an interdisciplinary research area where computer systems are used to study music. Single pieces as well as collections of IEEE 1599 documents can be automatically analyzed to extract meaningful information. The advantage offered by the format concerns the availability of an ecosystem of open and Web-available applications to provide learners with an effective interface to enjoy research results. This aspect is already present in the *IEEE 1599 Web Player*, under the area of diagrams and statistics, but at present it is mainly a proof of concept. The range of available analytical tools can be greatly extended and customized so as to answer specific research needs.

Finally, a relevant filed of application for the format is the study and promotion of music-centered cultural heritage. IEEE 1599 has been successfully used in a number of dissemination activities, including exhibitions at the Museum of *La Scala* theater of Milan, *Residenzgalerie* of Salzburg, and *Tinguely Museum* of Basel.[8] Even if these initiatives occurred in presence and do not specifically fall in the area of musicology, they have demonstrated the IEEE 1599's potential in the wider field of cultural heritage education.

Being available over the Web, didactic experiences can be remotely guided and customized to meet the learner's needs. This aspect is particularly relevant in higher education, where the skills and competences to develop can involve complex analytical tasks. Moreover, such a Web-based model can integrate synchronous and asynchronous peer-cooperation tools, including videoconferencing, chats, and forums.

5.2 Ensemble-Music Applications

As already discussed in literature (Baratè & Ludovico, 2012), IEEE 1599 can be employed also in the context of live musical and theatrical performances. During past experimentation, the idea was to simultaneously broadcast via the Web a number of synchronized media streams, so as to allow a distributed audience to configure their own experience by choosing in real time the audio track to listen to, the video take to watch, and the additional content (text information, graphical materials, etc.) to enjoy. In other words, the variety and number of media streams simultaneously broadcasted let the users choose – and reconfigure on the fly – their own combination of "foreground" content, thus personalizing the experience of the live event.

Provided that audio and video content are suitably acquired, such an approach can find a relevant application in music education, since it allows the

[8] A complete and up-to-date list of exhibitions is available at https://ieee1599.lim.di.unimi.it/practice_exhibitions.php

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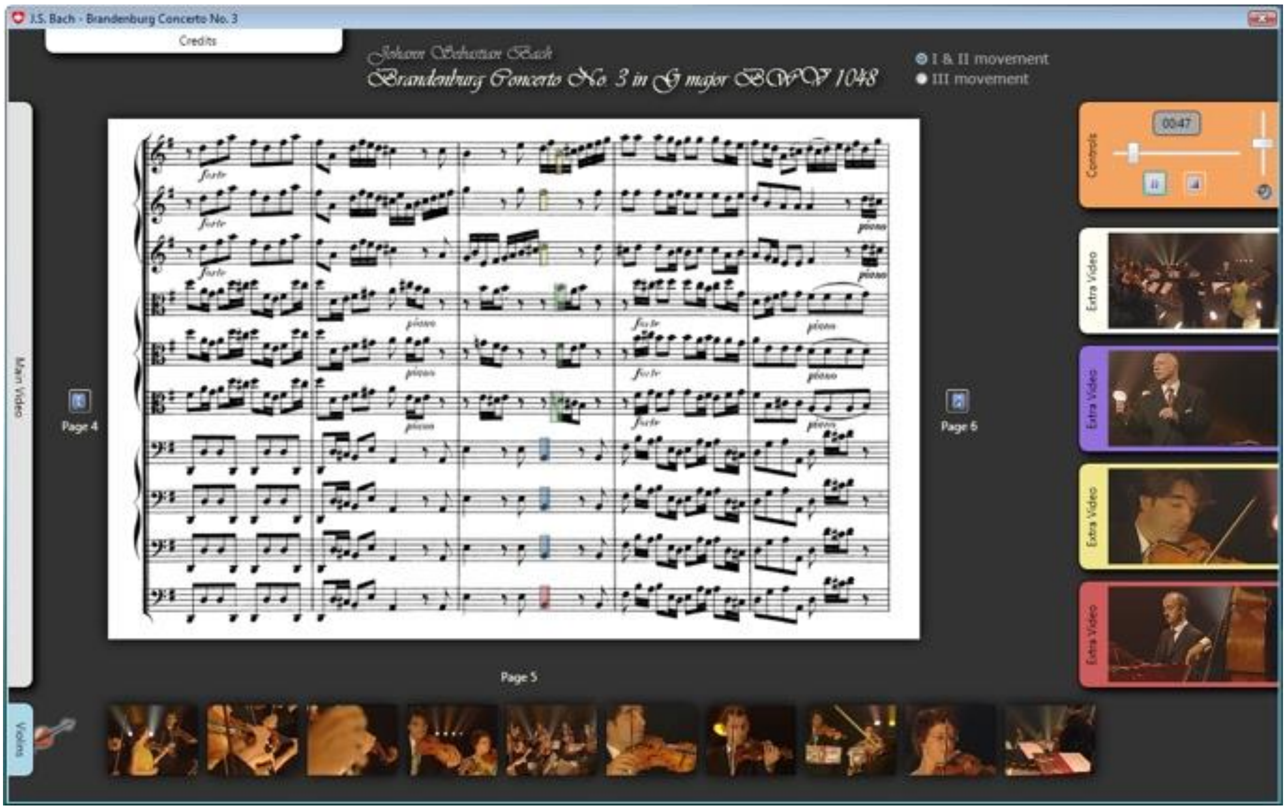

Figure 2 - The graphical user interface of the application dealing with the *Brandenburg Concerto No. 3* by J. S. Bach.

learner to focus on specific aspects (e.g., the hands of the piano player, the bowing of the violinist, etc.). In this sense, an early experimentation involved the University of Milan, the University of Applied Sciences and Arts of Southern Switzerland (SUPSI), and RSI Radiotelevisione Svizzera. The project focused on a performance of the *Brandenburg Concerto No. 3* by J. S. Bach encoded in IEEE 1599. The presence of 40 video tracks and an interface supporting the simultaneous experience of up to 5 multimedia streams (see Figure 2) allowed to analyze in detail the movements and gestures of each music player within the multi-layer and fully-synchronized environment already described. The application was released in 2007, one year before the official standardization of the format, and it was a stand-alone software for Microsoft Windows. In the following years, the synchronization engine was ported to the Web environment, so as to enjoy the IEEE 1599 experience in any HTML5-compatible browser.

Extending these concepts to curricular activities in music higher-education, IEEE 1599 can also support enhanced experiences of ensemble music, where performers are geographically distributed. With respect to the already mentioned scenario of live shows, in this case multiple streams are originated from remote nodes and combined together so as to form a unique performance. Based on a master tempo signal – not necessarily a fixed beat – shared by all musicians, audio content can be synchronized with score information, texts, images, graphical effects, etc., which is a typical advantage of the multi-layer approach of the format. All these elements have been already discussed in the context of advanced interfaces for music enjoyment, like in (Baratè & Ludovico, 2016), but they can be profitably applied, e.g., to a class of instrument students practicing together from remote locations under the guidance of a music teacher. In this scenario, IEEE 1599 can offer a number of advantages: for example, score alignment can help learners in keeping the pace; the availability of multiple score versions can improve readability by young musicians, thanks to a simplified or user-tailored notation (e.g., alternative symbols for visually or cognitively impaired learners); statistics and diagrams can foster analytical skills in order to better understand the music piece (e.g., recurrent rhythmical patterns or harmony-related features); and so on.

In all the scenarios described above, network technologies must be able to broadcast a huge amount of multimedia data, possibly preventing information loss and minimizing latencies. In this sense, a promising technological advancement is offered by 5G networks, whose documented features and expected advantages in the music field have been discussed in (Baratè et al., 2019).

6. Conclusions

Thanks to its characteristics, IEEE 1599 has constituted the theoretical and technological platform for a number

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of higher education experiences. For instance, it has been presented at the University of Milan during the doctoral course in “Computer technologies for musical information encoding”. In that occasion, observations and opinions by students in Musicology have been collected in the form of interviews. Remarks mainly focused on the applicability to specific domains (e.g., ethnomusicology or pop/rock music analysis), the workload required to encode a music piece in IEEE 1599, and the existence of a huge corpus of documents available for automatic analysis. As a further example, the format is regularly discussed under the perspective of information structuring in the Music Informatics Lab, a curricular course of the Bachelor’s Degree in Music Information Science given at the University of Milan. To pass the exam, students are required to encode in IEEE 1599 a music piece that, after the final evaluation and potential amendments, is added to the list of publicly-available materials, thus obtaining a “learn, implement, share” effect.

Concerning openness, the IEEE 1599 ecosystem allow for anywhere, anytime access to music information through a Web browser, and non-copyrighted content is available for free. Recalling Wiley’s 5 Rs presented in Section 2, the IEEE 1599 approach grants users the rights to retain, reuse, revise, remix, and redistribute music materials; in some cases, the format even encourages such activities: for example, the idea of employing content in a wide range of ways (reuse) and the possibility to combine content with other open materials in order to create something new (remix) underpin the key feature of the format, namely its multi-layer structure.

When applied to the music education field, IEEE 1599 can fully unveil its potential, fostering advanced and engaging ways to acquire musical skills and competences.

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