

Unlocking Music Archives: Openness and Accessibility

Vanessa Faschi, Federico Avanzini and Luca Andrea Ludovico*

Laboratory of Music Informatics, Department of Computer Science, University of Milan, via G. Celoria 18, 20135 Milan, Italy

Abstract

This paper focuses on the theme of unlocking the materials preserved by musical institutions such as opera houses, conservatories, and historical archives. In this context, “unlocking” means providing access to anyone, which can be interpreted in two different ways. The first meaning, related to openness, implies making preserved materials accessible to a wide audience. From this perspective, digitization campaigns and the subsequent enhancement of cultural assets through technology can open the way to new possibilities. For example, creating a dedicated Web portal can facilitate access by addressing issues such as physical distances, availability at any time of the day, the perishability of physical objects, insurance costs, etc. Moreover, technology can provide new services and foster advanced ways to exploit materials. Concerning the second meaning, related to accessibility, technologies can be used to assist people with physical and cognitive impairments and extend the use of these materials to people for whom it would be more difficult. For example, assistive technologies, such as screen readers or braille displays, allow blind and visually impaired (BVI) users to enjoy the transcription of music or literary texts. Similarly, computer-assisted approaches, such as large language models, can reduce the complexity of a text to meet the communicative abilities of people with special educational needs or cognitive impairments. To better illustrate the meanings of openness and accessibility, we will discuss two scenarios excerpted from the *Ricordi Historical Archive*. On the one hand, this work aims to highlight the fundamental role of technologies in supporting openness and accessibility, starting from digitization campaigns, through the online publishing of materials, to the release of ad hoc software tools. On the other hand, our research shows that there is still a long way to go before music archives can fully achieve the goals of openness and accessibility.

Keywords

Music, Archives, Collections, Accessibility, Inclusivity, Usability

1. Introduction

Music archives hold a wealth of cultural, educational, and research value, preserving the legacy of past generations and offering insights into the evolution of societies, institutions, and artistic expressions. By documenting recordings, sheet music, visual materials, personal papers, instruments, audiovisual content, publications, and digital resources, music archives respond to the need to preserve musical heritage for future generations. These archives, often housed within musical institutions such as opera houses, conservatories, and historical repositories, contain materials that are invaluable to musicians, scholars, and the general public. Despite their significance, the accessibility of these resources remains a pressing challenge. Ensuring that a wide and diverse audience can access and benefit from these materials is fundamental for fostering a deeper appreciation and understanding of cultural heritage.

In the digital age, technology has emerged as a pivotal tool in overcoming the barriers to accessibility inherent in traditional archival practices. Digitization campaigns, the creation of online repositories, and the development of user-friendly software tools can revolutionize the way we interact with archives. These advancements not only mitigate issues related to physical distance, limited access hours, and the fragility of physical objects but also open new ways for engaging with archival content. Open access can democratize the availability of these resources, allowing musicians, researchers, educators, and curious individuals to explore and use them in innovative ways.

Moreover, digital technologies offer significant potential for individuals with physical and cognitive impairments. Assistive technologies, such as screen readers and braille displays, and adaptations

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*Corresponding author.

✉ vanessa.faschi@unimi.it (V. Faschi); federico.avanzini@unimi.it (F. Avanzini); luca.ludovico@unimi.it (L. A. Ludovico)

ORCID 0000-0002-9815-1127 (V. Faschi); 0000-0002-1257-5878 (F. Avanzini); 0000-0002-8251-2231 (L. A. Ludovico)



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to simplify complex texts, ensure that archival content is accessible to all, regardless of physical or cognitive abilities. The dual approach to which we want to direct our work – i.e. broadening access for a general audience (openness) and catering to the needs of those with disabilities (accessibility) – underscores the multifaceted role of technology in preserving and disseminating cultural heritage.

To demonstrate such a role, this paper focuses on two use cases dealing with Giacomo Puccini's materials preserved at the *Ricordi Historical Archive*, specifically a handwritten letter and a score. By discussing these scenarios, we illustrate the practical implications of digitization and technological integration in making archival materials available and accessible to diverse audiences. Through this exploration, we aim to highlight the ongoing efforts and future directions necessary to fully realize the potential of digital archives in serving as open, inclusive, and widely accessible cultural repositories.

The remainder of the paper is structured as follows: in Section 2 we will describe the state of the art on the openness and accessibility of music archives, in Section 3 we will analyze the case studies inspired by the *Ricordi Historical Archive*'s collections, in Section 4 we will propose some strategies to unlock music archives, and, finally, in Section 5 we will draw the conclusion.

2. Music Archives: Openness and Accessibility

2.1. Definitions of Openness and Accessibility

Openness involves a set of principles and a range of practices through which outputs are publicly distributed, free of access charges or other barriers [1]. This fundamental concept promotes the democratization of information and resources, ensuring that knowledge is freely accessible to all, irrespective of geographical, economic, or social constraints. At its core, openness is guided by the belief that knowledge should be a public good, shared openly to foster innovation, education, and cultural enrichment. The principles of openness advocate for transparency and the unrestricted distribution of information. By eliminating access charges and other barriers, openness facilitates a more equitable dissemination of knowledge, enabling individuals and communities worldwide to benefit from and contribute to the collective pool of human understanding.

Based on the guidelines of W3C¹ *Web Accessibility Initiative (WAI)*², resources need to be accessible, usable, and inclusive, namely they must be easily used by any type of user. In particular, the term **accessible** refers to the possibility of guaranteeing equal use to people with or without impairments of any kind, both physical and cognitive. Everyone must be able to understand, interact, and contribute equally to Web resources. The term **usable** is closely linked to User Experience (UX) and User Interface (UI), which is the interface through which the user enjoys a resource. These aspects must be carefully designed to ensure an optimal experience for everyone, regardless of their impairment. Finally, the term **inclusive** is related to diversity. Diversity is about everyone, without any exclusion. The inclusion of every nuance must be ensured, from impairments to economic conditions, to every level and type of education, geographic location, age, culture, language, religion, and preference. In other terms, the inclusion of every diversity must be granted.

In this work, we bring to light the aspects of musical archives that require openness, accessibility, usability, and inclusivity, specifically presenting two case studies inspired by the collections of the *Ricordi Historical Archive*. Music archives offer an interesting field of application due to the nature of their materials, rare specimens, and unique pieces, whose supports may have aged to the point of compromising their content before being digitized. Music archives are typically closed, as their content can be accessed only by experts and scholars and handled through specific equipment. Accessibility is an even more crucial aspect. In fact, also in the case of digitized materials in good condition, there is still the need to make them usable and understandable by everyone.

¹World Wide Web Consortium, <https://www.w3.org/>

²Web Accessibility Initiative, <https://www.w3.org/WAI/>

2.2. Related works

The scientific literature includes numerous works that, on the one hand, highlight the lack of openness and accessibility of music archives for people with different types of impairments and, on the other, propose solutions to overcome these shortcomings.

Concerning digitized materials, one aspect to consider and carefully manage is that of metadata, usually expressed in the form of plain text information. Even if widely adopted to characterize data, metadata are seldom dedicated to accessibility purposes [2]. Instead, metadata could be used to let users with disabilities find resources more easily. Furthermore, metadata can greatly improve the performances of assistive technologies such as screen readers, as in the case of Semantic HTML and dedicated markup attributes (title, alt, lang, etc.) [3].

Music archives often contain autograph materials, difficult to read and understand, whose historical importance is right in the original handwriting. The transcription of handwritten texts is not a simple activity and often depends on the professional figure of the graphologist. The literature reports on the technological advances to extract textual content from images, both through Optical Character Recognition (OCR) [4] and via Handwritten Text Recognition (HRT) [5]. These techniques make manuscripts readable by text-to-speech systems and screen readers. In this way, text documents are accessible even to visually impaired people and users who prefer auditory information. The latest research in this field has also achieved good results in the recognition of cursive writing [6]. Music archives often preserve handwritten documents, e.g. records, contracts, and letters, as demonstrated by one of the case studies presented below.

An important category of materials for a music archive is the collection of scores. Once again, the digitization of images and their transcription into digital format are fundamental activities for accessibility. The automatic recognition of music symbols, known as Optical Music Recognition (OMR), poses further challenges [7] compared to OCR due to the complexity and variability of music notation. Recent advances involve Music Object Recognition (MOR) systems that permit resolving problems related to manuscript artefacts [8] and end-to-end OMR models to transcribe non-monophonic music scores [9].

Another accessibility issue concerns the retrieval and listening of archival audio collections [10, 11, 12]. Here, the demand for open access often conflicts with ownership rights. Some institutions, such as the Italian national audio record library,³ have the mission of preserving and granting access to sound documents and equipment; in other cases, such as at Teatro alla Scala, the audio archive is only one of many specialized archives. Please note that an audio document, intended here as an alternative rendition of a score, can represent a helping tool not only for BVI people but also for those who do not have the possibility or the ability to read music.

As mentioned before, the heterogeneity of the materials typically preserved in a music archive is huge: scores, audio and video recordings, photographs of performances and artists, posters, librettos, metadata referring to chronologies and casts, etc. In the case of an institution also involved in music production, e.g. an opera house, additional items such as stage props, maps, costumes and accessories, and wigs should be included. The complete openness and accessibility of such an archive necessarily involves the openness and accessibility of each of its components.

In [13], the author suggests five milestones on the road toward archival accessibility: 1. creating or acquiring and accessioning important collections, 2. processing the collections for complete accessibility in house, 3. describing collections online, 4. producing detailed finding aids on the Web, and 5. making archival collections themselves available on the Web. Although many music archives are on the right track, these recommendations assume the involvement and action of many different stakeholders, with different interests, which make it difficult to achieve these objectives.

³Istituto Centrale per i Beni Sonori ed Audiovisivi, <http://www.icbsa.it/>

3. Scenarios

To exemplify the issues and potentials related to music archives' openness and accessibility, we will discuss two scenarios, both inspired by the *Ricordi Historical Archive*.⁴ This Italian institution owns and preserves the original handwritten scores of 23 out of Giuseppe Verdi's 28 operas, all operas by Giacomo Puccini (except *La Rondine*), and numerous works by composers such as Vincenzo Bellini, Gioachino Rossini, Gaetano Donizetti and, more recently, Luigi Nono, Franco Donatoni, Salvatore Sciarrino, and Sylvano Bussotti. The great significance of the archive lies in the diversity of its materials, which offer an articulated view of the Italian culture, industry, and society. This archive preserves an extensive collection of visual materials associated with numerous premieres worldwide and locally, encompassing set and costume designs, photographs, correspondence, and business records.

The collection covers various artistic domains such as painting, stage design, and decorative arts, offering insights into costume history, jewelry design, stage properties, and the broader publishing landscape. The archive preserves approximately 8,000 scores, more than 16,000 letters exchanged among musicians, librettists, singers and other stakeholders, approximately 10,000 set and costume designs, more than 9,000 librettos, 6,000 historical photographs, and a substantial collection of Art Nouveau and Art Deco posters crafted by prominent artists of the era. Such an articulated scenario allows us to reflect on the themes of openness and accessibility in relation to the heterogeneity of materials typically preserved in a music archive (musical scores, monographs, iconographic materials, photographs, stage props, etc.).

Visual materials are publicly available on *Internet Culturale*⁵ the Web portal of the Italian National Library Service that provides a common access point for digital resources and catalogs of Italian libraries, archives, and cultural institutions. The portal, opened in 2005, aims to make catalogs and part of the information contained in public libraries available via the Internet. Digital reproductions accessible from *Internet Culturale* are mostly in the public domain and come from digitization activities carried out by libraries that are institutional partners of the portal. These libraries are the owners of both the originals and their digital reproductions.

3.1. Scenario 1: Handwritten Letters

The first scenario focuses on the letters and letter copies preserved in the archive. Even if this case may recall that of generic handwritten texts, please note that this kind of material can contain musical content as well, e.g. a draft of a musical theme or corrections made to certain passages of a music work.

The collection of autograph letters, about 15,000 in total, covers the time interval from the early 19th to the late 20th century. These letters were exchanged between Ricordi and writers, singers, and authors. These include composers such as Giuseppe Verdi, Giacomo Puccini, Franz Liszt, Ottorino Respighi, Jules Massenet, Alfredo Casella, and Luigi Nono; librettists such as Luigi Illica, Giuseppe Giacosa, and Arrigo Boito; renowned singers such as Teresa Stolz, Maria Waldmann, and Victor Maurel. In addition, there are extensive collections of handwritten or typed letters from the 20th century involving important Italian cultural figures, such as Gian Francesco Malipiero and Ildebrando Pizzetti.

On the one hand, specialized experts (e.g., musicologists, historians, sociologists, etc.) are interested in reading correspondence as it can shed light on the artistic, social, economic, and even personal aspects of the individuals involved. On the other hand, it would be important to grant access to these sources to all interested people, including impaired individuals and economically or culturally disadvantaged people, so as to bring a new audience closer to archival materials.

Unfortunately, these documents present numerous critical issues related to accessibility. Being objects of invaluable importance, it is paramount to protect them and preserve their physical integrity. In the case of the *Ricordi Historical Archive*, these items are physically stored in a vault, and access is possible only by appointment and reaching the archive's headquarters in Milan. In addition, the paper and ink

⁴*Archivio Storico Ricordi*, <https://www.archivioricordi.com/>

⁵*Internet Culturale*, <https://www.internetculturale.it/>

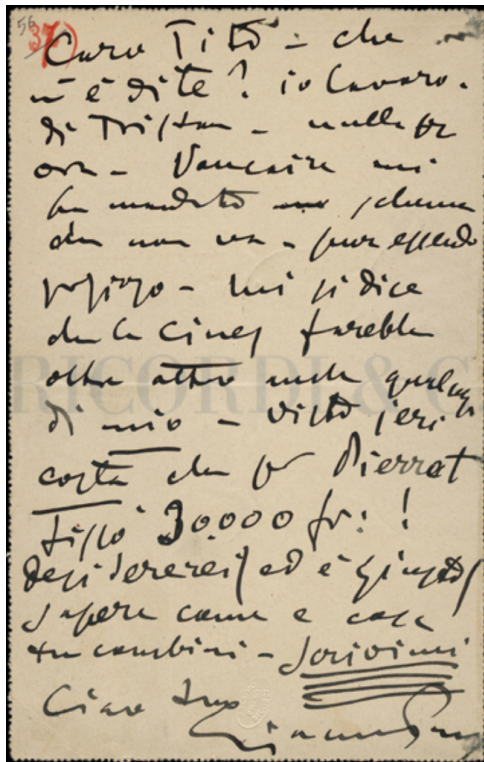


Figure 1: Handwritten letter sent by Puccini to the publisher Tito (II) Ricordi on July 17, 1913. Courtesy of the Ricordi Historical Archive.

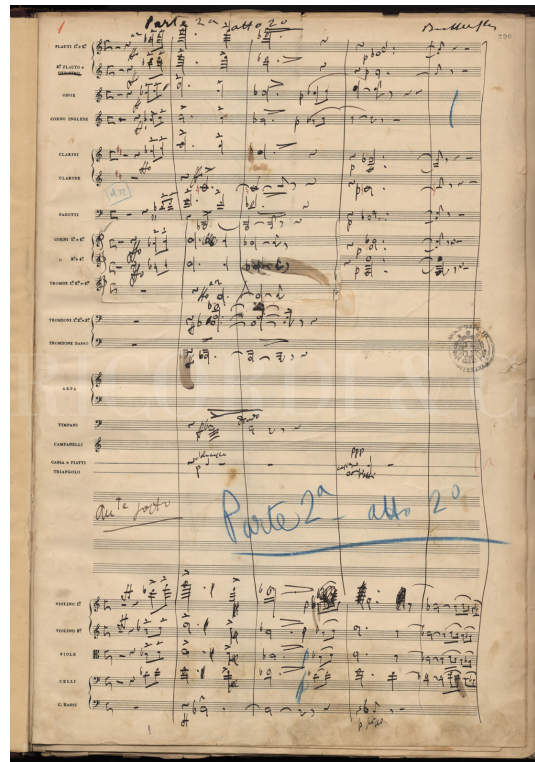


Figure 2: Giacomo Puccini, *Madama Butterfly*, Act 2, Part 2, page “03-Carta : 290r”. Courtesy of the Ricordi Historical Archive.

in use were not originally intended for long-term preservation; consequently, physical handling must be limited as far as possible.

After solving the first category of problems, i.e. obtaining access to materials, also their readability can pose critical issues. For example, handwritten signs can make content difficult to read. As a noticeable example, we take into account Giacomo Puccini’s handwriting style. Fig. 1 shows a letter sent by the composer from Viareggio, Italy to the publisher Tito (II) Ricordi on July 17, 1913. The letter is publicly available at https://www.internetculturale.it/jmms/iccuviewer/iccu.jsp?id=oai%3Awww.internetculturale.sbn.it%2FTeca%3A20%3ANT0000%3AMI0285_PUCCINII-056. Interpreting the graphical sign, even for a native Italian speaker, is not straightforward. The transcription, courtesy of the Ricordi Historical Archive, is:

Caro Tito - che n'è di te? io lavoro. di Tristan - nulla per ora - Vaucaire mi ha mandato uno schema che non va - pur essendo prolisso - mi si dice che la Cines farebbe oltre altro anche qualcosa di mio - visto ieri Costa che per Pierrot fissò 30.000 fr.! desidererei (ed è giusto) sapere come e cosa tu combini - Scrivimi
Ciao tuo Giacomo Pucci[ni]

and a possible translation into English is:

Dear Tito, what’s up with you? I am working. From Tristan, nothing for now. Vaucaire sent me a draft that is not good, despite being verbose. I am told that Cines would do something of mine in addition to other things. Yesterday I saw Costa who settled on 30,000 francs for Pierrot! I would like to know (and it’s right) how and what you are doing. Write to me.
Ciao, your Giacomo Pucci[ni]

The letter mentions Tristan Bernard, whom the composer approached for the completion of his project of a triptych. Puccini had already composed one opera out of three, namely “Il tabarro”. Bernard

proposed a fairy tale as the subject for another part, but the project was abandoned since Puccini chose the one-act operas “Suor Angelica” and “Gianni Schicchi” by Gioacchino Forzano to complete the triptych. Maurice Vaucaire was a playwright, poet, and librettist who worked on the French translations of Puccini’s “Manon Lescaut” and “La Fille du Far West”. Finally, the letter mentions “Histoire d’un Pierrot”, a silent film directed by Baldassarre Negroni, released in 1914, distributed by Cines, with music by Mario Pasquale Costa.

This short explanation of the semantic content highlights two additional problems falling in the category of text accessibility. First, the language in use can be different from the current one, even for a native speaker. Luckily, this is not the case with the letter under exam. Secondly, the full comprehension of the text requires an in-depth knowledge of the context: the references to other people (Tristan, Vaucaire, Costa), entities (Cines), and other works (Pierrot), and the use of abbreviations as well (fr. for francs), make the interpretation of the message quite cryptic.

Nevertheless, it is evident how a few lines of text can provide valuable information about the contacts between Puccini and other intellectuals, the journey of the composer’s works, and even economic and financial aspects, offering a glimpse into the cultural climate of the time. Furthermore, beyond their content, letters allow for an investigation into the character and inclinations of the writer and to deepen the understanding of the relationship between the correspondents.

A special mention should be made of the limitations concerning search and indexing of paper documents. For instance, finding all the letters in the archive where Puccini mentions a colleague or discusses the payment for an opera would require a deep knowledge of all the preserved materials. The use of metadata, mentioned in Subsection 2.2, would help in this context.

3.2. Scenario 2: Scores

The second scenario concerns the openness and accessibility of scores. Many of the issues regarding physical access to materials have already been mentioned in the previous section. Examining the autograph scores of Verdi or Puccini in person is not an option available to the average visitor. Being cultural assets of immeasurable value and made of perishable materials, it is necessary to limit physical access to these objects as much as possible. Indeed, the autograph scores are shown to the public only during exhibitions and events, well protected by glass cases, allowing only the open pages to be seen.

But symbolic information is also critical in terms of accessible representation of content. Let us mention the challenges for blind and partially sighted musicians. For individuals seeking physical copies of accessible scores, there are two primary options: large print (also called Modified Stave Notation or MSN) [14] and braille music [15]. The former offers a customizable format particularly beneficial for partially sighted musicians, facilitating adjustments such as resizing specific notation elements and modifying spacing, layout, and line thickness. In contrast, braille music, an extension of the braille literary code, serves as a viable option for blind musicians. Unfortunately, these solutions are not directly applicable to a traditional music archive, whose purpose is mainly to preserve cultural heritage in its original form.

Autograph scores are even harder to make accessible than printed ones, above all those containing common Western notation. Often, the aspect of greatest interest to the viewer, whether a scholar or a mere enthusiast, is the handwriting style. Moreover, ancillary signs typically omitted in a printed edition (e.g., working indications and corrections) are of paramount interest. Even if the symbolic content were correctly rendered, the original aspect would be very hard to return to BVI people. Providing a version accessible for BVI people and capable of returning Puccini’s handwriting style is possible, both in the analog domain (e.g., by engraving a surface) and in the digital domain (e.g., by using images with high contrast or tactile graphics), but is not as straightforward as converting symbolic information, say, into braille.

Once again, let us refer to the materials of the *Ricordi Historical Archive* to exemplify the scenario, and, specifically, to a page excerpted from *Madama Butterfly* by Puccini (see Fig. 2).⁶ In addition

⁶The page is publicly available at https://www.internetculturale.it/jmms/iccuviewer/iccu.jsp?id=oai%3Awww.internetculturale.sbn.it%2FTeca%3A20%3ANT0000%3AMI0285_MS_RARI_G5_01-03.



Figure 3: A multimedia installation based on *Ricordi's* materials installed at La Scala theater, Milan, September 2017 – January 2018.

to the autograph musical notation, the page contains additions and deletions that reveal Puccini's compositional process, along with multiple annotations added at various stages using colored pencils.

4. Discussion

4.1. The Role of Digital Technologies

To overcome the problems that hinder archive openness and accessibility, digital technologies can provide effective solutions. This approach embraces (at least) three aspects:

1. **Digitization** – This term identifies the process of converting physical materials into digital formats, enabling easier access, preservation, and dissemination of information. Please note that music archives can also contain born-digital materials, as in the case of stage photos taken by digital cameras or score editions produced via digital score editors;
2. **Cataloging and indexing** – Cataloging involves both descriptive metadata, namely detailed descriptions of each digitized item (e.g., title, author, date, etc.), and technical metadata (i.e. information about the digitization process, such as scanner settings, file formats, and resolution). Indexing refers to the process of creating a structured system to organize, categorize, and retrieve digitized materials efficiently, thus making it easier for users to search and access specific content;
3. **Exploitation and distribution** – Ad hoc user interfaces can support searching, browsing, and interacting with digitized content. In this context, the goal is to provide also impaired people with a smooth and pleasant user experience. These interfaces can be designed for online or offline use, but, in the latter case, huge access is harder to guarantee, requiring a “here and now” model of experience. Possible examples are multimedia installations and kiosks publicly available at exhibitions, such as the one shown in Fig. 3.

The importance of technology-enhanced approaches is now evident to many stakeholders, including the most traditional ones [16, 17, 18]. One of the reasons not mentioned so far lies in the new perspectives for content access, including so-called music information retrieval (MIR) [19].

Unfortunately, digitized collections remain a minority among the vast array of records held by cultural institutions. This is due not only to the high costs and technical expertise required for producing top-quality digital copies and metadata but also to the inherent limitations in digitizing all collections. Firstly, technological obsolescence presents challenges in accessing materials stored in outdated formats. While scanning paper materials or photographing physical objects poses no problems, consider the case of having to acquire audio information saved on magnetic wire or wax cylinder. Similarly, finding

equipment capable of reading magnetic tapes in VHS or Betamax format is increasingly difficult. Secondly, digitization programs often prioritize certain materials considered “high priority”, leading to the exclusion of perishable materials deemed less significant or valuable. Thirdly, copyright issues may prevent or discourage the release of certain collections, even when digital copies exist [20].

In this regard, the *Ricordi Historical Archive* represents a virtuous case. Almost all of the collections have been digitized and indexed, and many of the items have been made available in digital format on various institutional Web platforms, including the abovementioned *Internet Culturale* portal.

Even if most of the activities described so far fit the goals of opening archives in general, some aspects are peculiar to music archives. The richness and heterogeneity of a music archive lie in its ability to preserve and present a diverse array of materials that reflect the multifaceted nature of music as an art form, cultural expression, and social phenomenon. A music archive typically preserves sheet music, audio recordings, visual materials such as photographs, posters, and concert flyers, correspondence and personal papers, tools and equipment, audiovisual materials, and publications. Translated into the digital domain, a music archive holds heterogeneous media objects including texts, images, audio tracks, video content, and music scores. Furthermore, within a music archive, many materials exhibit relationships that extend far beyond the typical ones retrievable in a relational database. For instance, score, audio, and video materials referring to the same music piece can be synchronized to realize score-following applications.

For the general audience, this scenario enables the design and implementation of particularly rich user interfaces with specific forms of interactivity, such as the score follower shown in Fig. 3. But, in the context of accessibility, the interconnection of multiple materials also fosters the design of multimodal interfaces, where impaired senses can be compensated through sensory substitution tools.

4.2. Making Archive Content Accessible to Impaired and Disadvantaged People

In this section, we will address good practices to make music archives **accessible**, **usable**, and **inclusive**. Digitizing materials is a crucial step in opening the shrine of music archives, but is not enough to make them enjoyable for everyone. In this context, it is essential to consider how stakeholders manage access to digitized objects. A widespread practice from archives, theaters, and other institutions is to keep digitized material reserved for internal use with the aim of consultation or mere preservation. There can be many reasons for such a policy, ranging from rights management to the protection of the economic value of an archive, from the lack of a dedicated technological platform to the absence of a vision focused on open access.

Now we propose some approaches to broaden the audience of music archives, which should include, to cite but a few examples, scholars with physical impairments, enthusiasts with no access to adequate music education, foreign people who do not understand the original language of a document, and users with cognitive impairments who understand differently what they are reading or listening to.

4.2.1. Distributing Digitized Archival Content

The first step towards openness and accessibility of archive materials is the dissemination and distribution of their digitized versions. Stakeholders can adopt several strategies and approaches, such as showcasing digital materials during open events and implementing publicly available offline applications, but an effective way is to organize digital data and metadata in a multimedia database and release ad hoc Web platforms.

The potential of the so-called semantic Web can also be effectively exploited in the field of cultural heritage, using technologies and ontologies specific to this domain [21, 22, 23]. The semantic Web fosters the interoperability and integration of information from different sources, enhances the ability to perform complex searches, and allows data visualization through advanced tools (such as knowledge graphs).

4.2.2. Coexistence of Public and Private Places to Access Music Archives

Accessing digitized materials on the Web requires an electronic device (e.g., a personal computer, a tablet, a smartphone, etc.) and an Internet connection. Even if Internet connections are more and more widespread, there are still people “offline”, depending on age, education, technological or economic reasons. For example, conditions of geographical isolation or social disadvantage can bring educational poverty and prevent access to digital resources. This condition is captured by the term “digital divide” which refers to disparities in Information and Communications Technology access, usage, and outcomes [24]. To make a Web-based approach inclusive, we encourage the presence of easily accessible public spaces equipped with ad hoc tools, such as Web-connected personal devices or shared totems. These devices can be installed in the institutions that host the archives as well as in other public spaces such as libraries, schools, and universities. An example is the digital music collection of the *Biblioteca Europea di Informazione e Cultura* (BEIC), which hosts thousands of audio tracks that can be fully accessed only by connecting one’s personal device to the institution’s internal network; otherwise, only a 30-second preview is available.

With the coexistence of private and public spaces, equal opportunities are offered, on one side, to people who cannot physically go to a specific site, allowing them to find what they are looking for in a Web portal, and, on the other side, to people not owning a suitable device or Internet service to let them enjoy materials in a space open to everyone.

4.2.3. From Physical Documents to Digital Information

Starting with the non-trivial assumption that the contents of the archive have been digitized, organized, and enriched with descriptive and technical metadata, the problem becomes how to represent in an inclusive way the information they carry. Automatic or supervised tools can come into play to extract information from a physical object and make it accessible in the digital domain.

Referring to the case of the letter in Section 3.1, it is common to consider descriptive metadata such as date, sender, and recipient, and extract technical data from the file itself. However, it would be useful to provide an alternative description of the content to make it accessible even to the BVI. In the case of a letter, it is also important to transcribe its content into plain text. Transcription can be useful not only for an aiding device, such as a screen reader or a braille display, but also to allow rewriting the text with the aim of a large language model, so as to update it to the current language or make it more understandable to young or cognitively impaired readers.

Also for handwritten or printed scores, as shown in Section 3.2, digitization should be followed by transcription. In fact, in the absence of the latter activity, the digital copy of a physical score would remain largely inaccessible to people with visual impairments and incomprehensible to people who cannot read it. Textual metadata, if present, can alternatively be shown by a screen reader or a braille display, but symbolic information would be unavailable to disadvantaged users.

Optical Music Recognition (OMR) systems, increasingly specific and accurate, provide a solution. Unfortunately, these automatic tools are still experiencing problems with handwritten notation, but new approaches based on computer vision and machine learning are paving the way to new possibilities [25]. Transforming a physical score into a digital one makes it possible to generate sound renditions such as MP3 or MIDI files. Moreover, music symbols can be exported to more accessible formats, such as braille music. Other interchange formats, e.g. MusicXML [26], can be used as a bridge to other computer-based applications. As an example, *Talking Scores* [27] is a tool that entails a verbal rendition of score details (e.g., note, duration, expression) accompanied by brief musical excerpts. Other significant uses of MusicXML as a bridge to other applications are provided by *MakeBraille*,⁷ *BrailleMuse*,⁸ and software from *Sao Mai Braille* and *Dancing Dots* that facilitate the conversion of MusicXML into braille.

Desktop and mobile applications such as *Power Music*⁹ and *forScore*¹⁰ should also be reported. They

⁷<https://makebraille.dzbleesen.de/MakeBraille>

⁸<https://www.braillemuse.net/>

⁹<https://powermusicsoftware.com/>

¹⁰<https://forscore.co/>

are digital score readers, scanners, managers, and organizers, and enable users to enlarge digital sheet music, import PDF files, and perform playback operations such as adding a metronome to the digital score.

Unfortunately, the issue of providing an accessible counterpart of the original image remains unsolved for BVI people. The richness and cultural interest of handwritten notation and autograph writing can be returned only in alternative ways. A typical form of sensory substitution in use for artwork, i.e. haptic reproduction, can be implemented only in a physical space.

This problem is even more critical when the original materials are three-dimensional objects and two-dimensional representations cannot catch their content completely, as in the case of costumes and wigs. In this field, 3D printers still represent an impractical solution, as they are not widely available at a personal level, require ad hoc models of the objects to be rendered, are limited concerning printable materials, and are too slow for on-the-fly fabrication.

4.2.4. The Pivotal Role of User Interfaces

Central to the theme of accessibility is the role of user interfaces (UIs), not only for enhancing user experience but also for ensuring that music content is accessible to all individuals, regardless of their abilities or technological proficiency.

A well-designed UI can significantly enhance the user experience by making it intuitive, efficient, and enjoyable to navigate archive content. A seamless UI ensures that users can focus on the content itself rather than struggling with navigation or functionality issues, thereby fostering a deeper engagement with the music-related content.

Web UIs serve as the bridge between users and the repositories of music available online. One of the most crucial aspects of Web UIs is their role in making music content accessible to everyone, including individuals with disabilities. Web accessibility involves designing interfaces that can be used by people with a wide range of abilities and disabilities. For example, visually impaired users usually rely on screen readers to navigate Web pages. Ensuring that an interface is compatible with screen readers means providing descriptive alternative text for images, using semantic HTML for better structure, and supporting keyboard navigation. People with hearing impairments can benefit from features such as subtitles for music videos, lyrics display, and visual cues for audio content. Web designers and developers can refer to the WAI guidelines to create accessible content that ensures accessibility.

The implementation of accessible UIs requires a concerted effort from designers, developers, and content creators. It involves the integration of various technologies and best practices to ensure that the UI is user-friendly and compliant with accessibility standards. This includes responsive design to cater to different devices, intuitive layout and navigation, and robust testing with assistive technologies. Continuous feedback from users with disabilities is also vital in refining and improving the accessibility of the platform.

Accessible UIs contribute to the cultural enrichment of society by democratizing access to diverse musical genres and artists. This cultural inclusivity promotes a richer and more diverse musical landscape.

4.2.5. Designing and Implementing Multimodal Representations

Since music archives typically contain heterogeneous information and music-related content lends itself to forms of integrated visualization (for example, a score follower synchronizes score images and audio tracks), a special category of applications concerns multimodal access [28, 29]. *Multimodality* refers to the use of multiple sensory modalities to convey information, engage users, and facilitate interactions. In the context of overcoming impairments, multimodality is a powerful approach that can significantly enhance accessibility and inclusivity. By leveraging different modes of communication, such as visual, auditory, and tactile inputs, platforms and interfaces can be made more usable for people with various disabilities.

By providing multiple ways to access information, multimodal interfaces ensure that users can choose the mode that best suits their needs. This form of redundancy is crucial for overcoming the limitations posed by specific impairments. By catering to different sensory preferences and needs, these interfaces can make interactions more enjoyable and effective.

Finally, the incorporation of multimodal elements can ensure that interfaces remain accessible and adaptable to new developments. This adaptability is essential in creating sustainable and long-lasting accessibility solutions.

A notable example of a structured approach to multimodal representation in music archives is the IEEE 1599 format [30]. Designed as a multilayer framework for encoding music information, IEEE 1599 integrates different modalities within a single structured document, including symbolic notation, audio recordings, visual representations, and analytical metadata. This format enables precise synchronization between heterogeneous content, facilitating advanced applications such as score-following systems, interactive music analysis, and educational tools. Moreover, its layered architecture allows for personalized accessibility features, such as dynamic adaptation for visually impaired users through braille notation or for hearing-impaired users through haptic feedback. By adopting IEEE 1599, music archives can enhance openness and accessibility, ensuring that users with diverse needs can engage with musical content in a flexible and inclusive manner. Other multilayer formats for music description, such as MEI and MusicXML, have been described in [31].

5. Conclusions

The goal of this work was to investigate the aspects of openness and accessibility in music archives. Unlocking music archives has a significant importance in various domains, including cultural preservation, academic research, education, and personal enjoyment. Ensuring that these archives can be accessed offers numerous benefits, encouraging a deeper understanding and appreciation of music and its role in society.

In this context, user interfaces play a key role. They can enhance user experience, ensure accessibility, and contribute to cultural diversity. As technology continues to evolve, it is imperative that new platforms prioritize the development of accessible UIs capable of transcending barriers in music archive exploration.

There is growing awareness towards the issue of openness and accessibility. Openness has long been at the center of scientific and cultural debate. Suffice it to mention open access in scientific publications or open data released by governments and public institutions. But accessibility is also becoming more and more prominent in the debate. Formats such as braille music, aiding devices such as screen readers, and technologies such as the Web Speech API can help make music archives more accessible.

To achieve these goals, the managers of music archives, stakeholders, and policymakers must do their part, opening archives to the outside world in an accessible and inclusive manner, implementing best practices, and ensuring an enjoyable experience for impaired or disadvantaged users.

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