array

ARRAY2020 – *Archiving*

The International Computer Music Association

President: Tae Hong Park
Vice President for Membership: Michael Gurevitch
Vice President for Conferences: Rob Hamilton
Vice President for Asia/Oceania: --
Vice President for the Americas: Eric Honor
Vice President for Europe: Stefania Serafin
Vice President for Preservation: Tae Hong Park
Music Coordinator: PerMagnus Lindborg
Research Coordinator: Christopher Haworth
Publications Coordinator: Tom Erbe
Treasurer/Secretary: Chryssie Nanou

Board of Directors 2018/2019

At-Large Directors
Miriam Akkermann
Mark Ballora (+)
Lauren Hayes
John Thompson

Americas Regional Directors
Rodrigo Cadiz
Charles Nichols

Asia/Oceania Regional Directors
PerMagnus Lindborg
Takeyoshi Mori

Europe Regional Directors
Kerry Hagan
Stefania Serafin

Non-Elected Positions:
ICMA Administrative Assistant: Sandra Neal

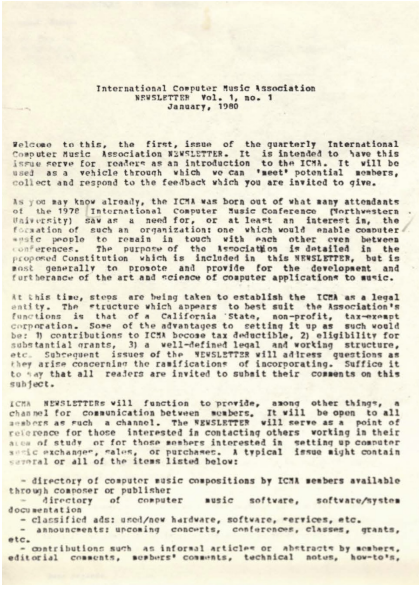
Main Editor Array: Miriam Akkermann
Published by International Computer Music Association ICMA 2020
1819 Polk Street, San Francisco, California 94019, USA
DOI: 10.25370/array.v2020
https://journals.qucosa.de/array/ www.computermusic.org

Editorial

With this issue, array is welcoming you to the new virtual home of International Computer Music Association ICMA's journal: https://journals.qucosa.de/array.

At this point – and against the background of the topic "archiving" of this current issue – it is reasonable to briefly look back at the history of array, which is interwoven with the history of the ICMA, and also to think about *Array's* own archive.

The ICMA has been co funded by Curtis Roads, John Strawn and Thom Blum in 1978/79. Thom Blum, the first editor of *Array*, started the journal in 1980 as the organization's quarterly newsletter, explaining that he came up with the name *Array* " […] because it could be interpreted both as a data structure that's fundamental to our art as well as a description of the open, diverse information that members could contribute and expect in the (roughly) quarterly issues." (Thom Blum, Email to M. Akkermann 2020) Designed as a member's counterpart to the MIT Press Journals' Computer Music Journal (CMJ), *Array* was intended to serve the



International Computer Music Association
NEWSLETTER Vol. 1, no. 1
January, 1980

Welcome to this, the first, issue of the quarterly International Computer Music Association NEWSLETTER. It is intended to have this issue serve for readers as an introduction to the ICMA. It will be used as a vehicle through which we can 'meet' potential members, collect and respond to the feedback which you are invited to give.

As you may know already, the ICMA was born out of what many attendants of the 1978 International Computer Music Conference (Northwestern University) saw as a need for, or at least an interest in, the formation of such an organization: one which would enable computer music people to remain in touch with each other even between conferences. The purpose of the Association is detailed in the proposed Constitution which is included in this NEWSLETTER, but is most generally to promote and provide for the development and furtherance of the art and science of computer applications to music.

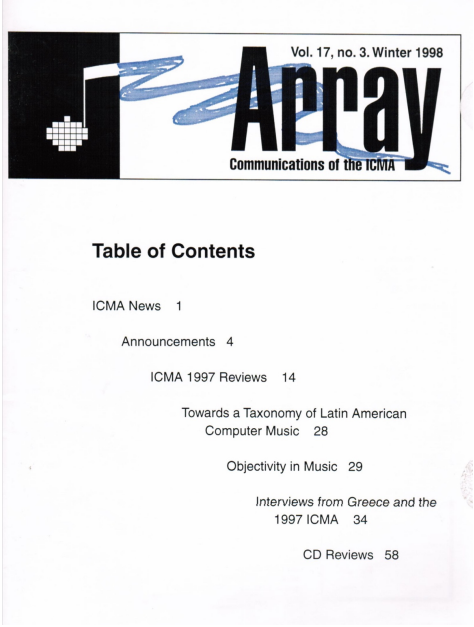
At this time, steps are being taken to establish the ICMA as a legal entity. The structure which appears to best suit the Association's functions is that of a California State, non-profit, tax-exempt corporation. Some of the advantages to setting it up as such would be: 1) contributions to ICMA become tax deductible, 2) eligibility for substantial grants, 3) a well-defined legal and working structure, etc. Subsequent issues of the NEWSLETTER will address questions as they arise concerning the ramifications of incorporating. Suffice it to say that all readers are invited to submit their comments on this subject.

ICMA NEWSLETTERs will function to provide, among other things, a channel for communication between members. It will be open to all members as such a channel. The NEWSLETTER will serve as a point of reference for those interested in contacting others working in their area of study or for those members interested in setting up computer music exchanges, sales, or purchases. A typical issue might contain several or all of the items listed below:

- directory of computer music compositions by ICMA members available through composer or publisher
- directory of computer music software, software/system documentation
- classified ads: used/new hardware, software, services, etc.
- announcements: upcoming concerts, conferences, classes, grants, etc.
- contributions such as informal articles or abstracts by members, editorial comments, members' comments, technical notes, how-to's,

First page *Array* 1(1), 1980

ICMA members with information on computer music events, announcements and reviews, as well as with a small sell-and-search section. As Blum remembers for the very beginning: "Every issue was handmade and put together, much like a Tape Music piece, by physical cutting and pasting, photocopy layout iterations […], then taking the master to a photocopy shop and finally addressing, stamping, and dropping the issues at my post office." (Blum 2020)



Front Cover *Array* 17(3), 1998

Over the last 40 years, *Array* changed its appearance and frequency several time. editors and co-editors were:

Thom Blum (1980-88);
John Worthington (1988)
Carla Scaletti&Kurt Hebel (1990-92)
Brad Garton&Robert Rowe (1992-95);
Katharine Normann (1996-98);
Mara Helmuth&Jøran Rudi(1998-04);
Margaret Schedel (2004);
Margaret Schedel&Jennifer B. Merkowitz (2006-08);
Jennifer B. Merkowitz (2008-11);
Scott McLaughlin (2011-13)
Christopher Haworth (2014-17);
Patricia Alessandrini, Shelly Knotts &Christopher Haworth (2018)
Miriam Akkermann&Rama Gottfried (2019).

Many issues have been published, and not all have found their way in a digital documentation of array yet.

Being hosted on musiconn.publish, an information service specialized for musicology funded by German Research Fund, which is jointly operated by the BSB Munich and SLUB Dresden offering amongst others long-term archiving of musicological literature, ICMA has now the possibility to provide a sustainable open access for upcoming issues of array, as well as the possibility to retrospectively integrate former issues.

Thus https://journals.qucosa.de/array will become array's new virtual representation and it's new archive.

With this in mind, I wish you both a good read of the current issue and a lot of fun browsing through the past issues, which will be put online on the platform bit by bit.

Special thanks to: T. Blum, C. Harris, C. Haworth, M. Helmuth, C. Roads, R. Rowe, M. Schedel, and T. Erbe.

Introduction

by Miriam Akkermann

This issue of ICMA's array is dedicated to the topic "Archiving" and presents a variety of perspectives, approaches, and projects related to archiving, preserving, and re-performing of electroacoustic and computer music by researchers and practitioners.

Archiving cultural objects of contemporary history plays an increasing role in current research. This includes also a constant reflection of the handling of archives, their structures, and their accessibility. Preserving music faces both a long tradition of music libraries, instrument collections and compilations of sound recordings employing different media one the one hand, and new challenges deriving from digitization and new media formats on the other. Especially for digital (media) data, preserving existing works becomes increasingly urgent, the more the loss of content is impending. The spirit of the continuously faster developing field of digital technologies also causes a faster decay of its children. Projects on digital forms of archiving and editing music notation have been ongoing already for several years (e.g. such as The Music Encoding Initiative MEI, https://music-encoding.org, last access Sept 20, 2020), and it is assumable that they may increasingly replace traditional printed forms of publication in the coming years. In contrast, the 20th and 21st century born field of electroacoustic music and computer music can – yet – look back neither on a tradition of standardized documentation nor common initiatives for strategies on archiving and preservation. The need of valuable strategies, however, becomes more and more obvious.

Besides qualitative debates about an adequate technical configuration of the data to be preserved, it is also necessary to communicate about new approaches to archiving strategies. This includes dealing with the composition's basic information as well as the question of how to deal with involved (digital) technology which is practically bound e.g. to obsolete hardware systems and connected software compatibility problems. Hereby, archiving can aim for several different purposes, ranging from a pure preservation of original content

to collecting and keeping information updated for (re-)performances of musical works (cf. e.g. Lemouton/Goldszmidt 2016, hal-01944619). This is particularly relevant in so far as the information archived concerning a musical work can strongly influence its possible future appearance (cf. Akkermann 2019, http://doi.org/10.5281/zenodo.3484546).

The presented articles in this issue of array mirror discussions that have already been tackled at the ICMC panel sessions on "computer music heritage" 2018 in Daegu/KOR, hosted by Kevin Dahan, and "archiving" 2019 in New York/USA, hosted by TaeHong Park, involving also the other authors and the editor of this issue. The panels have shown that there is a broad interest in the community and a need for more discussion. In the following, some of the mentioned aspects are now connected to most recent reflections, considerations, projects and debates, providing a broad and substantial starting point for a future debate on archiving approaches and projects.

The electroacoustic repertoire: Is there a librarian ?

by Serge Lemouton

Introduction

Until proven otherwise, our civilization is still a civilization of the Book. Libraries are the places where books are transmitted over time. Works of plastic art, paintings, sculptures, are exhibited, preserved, restored in museums, with the specific difficulties posed by the materials and techniques used. Cinematographic works have their cinematheques, but seem more difficult to preserve when we realize that some films have already completely disappeared. We can consider a musical work as a text: musical works in the form of written, printed or handwritten scores also have their libraries. But what happens when music, since the advent of possibilities opened up by the means of technical reproduction, includes elements that are not strictly notated in form of text? We are interested here specifically in music of scholarly or experimental tradition (real-time electronic music) using new instruments such as synthesizers, samplers, effects, pre-re-

corded sounds, amplification devices and spatial sound diffusion as well as all kind of sound devices or computer music system.

Paradoxically, digital resources need more care to be preserved than information written on paper. The inherent fragility of digital materials leaves only a small window of time during which they can be preserved before being erased forever. The electro-acoustic music works considered therefore pose specific problems of transmission and diffusion; these problems, of various natures, are beginning to be recognized and studied. This repertoire has grown throughout the last century and is very important both in terms of the number of works and of interest in the history of musical art. And it became so important that these new instruments and digital means will infuse the vast majority of current musical creation in all directions. Within the framework of a recent working group, we were interested in the methods of "how" to preserve, and in the inscription and the dissemination of this repertoire, but not really in the question of "who" is preserving: who has the responsibility, the duty to ensure its conservation for future generations?

Who should assume this role? Is it the composer, the performer, the publisher, the musicologist, or the music historian? Is this responsibility collective or individual?

Composers

We can think that the first actor involved in the preservation of musical works should be the author. First of all because it seems obvious that composers from the Western tradition write music for the posterity. Secondly, because it seems that they are the first ones to have the moral duty to preserve their productions. In practice, however, we observe that this responsibility is rarely assumed by the composer.

Here we can question the notion of the work of art as artefacts built for the posterity. Is writing for future centuries historically situated, is it a notion born with romanticism? Music is an ephemeral art, but isn't the urge to leave a trace consubstantial with all artistic practice since the origins of humanity?

In the specific case of contemporary music, we observe a paradox: the composer notates the instrumental part more and more precisely, while

the electronic part (in general, however, so essential to the work that one cannot envisage to play the piece without) is not fixed (at least very rarely by the composer himself).

While some composers have been actively engaged in documenting, preserving and transmitting the electroacoustic part of their works, this is not generally the case. We can cite the case of Karlheinz Stockhausen, a composer characterized by an extreme control on his works, who himself produced a critical and complete edition of his scores. This edition is so exhaustively detailed that we can predict that its preservation is assured. But this case seems rather the exception in the context of contemporary music. What we learn from this particular case is also that we must not neglect the role of the artist's family in this question of preserving an artistic heritage.

One can wonder about the reasons for this fairly constant lack of interest among composers for the documentation of the electroacoustic part of their pieces. Is it because of a theoretical difficulty or a practical impossibility? Is it an educational problem? Is it due to the lack of theoretical means (it is well known that there is no standardized notation for electroacoustic devices which could play a similar role as traditional music theory does for the notation of instrumental music)? Is it simply for practical reasons (preserving software data requires an appropriate infrastructure)? It can also be due to a lack of knowledge on the developments of languages and computer systems — but who in this area can claim to master the complex issue of obsolescence and prophesy about the evolution of computing?

Why do composers not have the will to write the electronic part of their works? Do they consider that the electroacoustic part of their work is secondary, accessory, less noble than the instrumental part?

The electronic part can also be the result of a collaborative work, it is sometimes co-composed or co-produced by what is generally called a "computer music designer". It can also sometimes be entirely produced by the latter; in this case one may wonder whether it is really up to the composer to include it in the score.

The question of safeguarding this repertoire is all the more crucial today as the first generation of composers to use the means of expression

offered by computer music are slowly but inevitably disappearing. If they are the ones who should store their own computer archives, what is left after? Is it up to their possible heirs or beneficiaries to preserve their archives? We can cite Pierre Henry as a successful example, whose home studio and domestic sound library are saved for the future, finally supported by both the National Library of France (cf. https://www.bnf.fr/fr/toute-loeuvre-de-pierre-henry-la-bnf) and the Philharmonie de Paris (cf. https://philharmoniedeparis.fr/fr/musee-de-la-musique/collection/parcours#studio-pierre-henry, last access Sept. 14, 2020), thanks to the commitment of its beneficiaries. After the passing of Jean-Claude Risset, his archives were finally taken care of by a CNRS laboratory (cf. https://musinf.univ-st-etienne.fr/SiteRisset/archives.html, last access Sept. 14, 2020).

Computer Music Designers

Although there is some recent work on the position of computer music designer in electroacoustic music (Zattra 2016), the nature of their activity remains largely unknown. Indeed, their activity is not limited to the "design" of the computer part of the musical works in which they collaborate, but also encompasses (among others) interpretation, documentation, archiving, and updating the pieces from their personal repertoire.

The computer music designers are, by virtue of their activity as performers, experts in the question of the evolution of computer music environments. Their job and the rapid development of computer music tools require them to always be in "technology watch" mode. Indeed, among the many tasks implied by their position as *Réalisateur en Informatique Musicale* (or RIM, french for Computer Music Designers), porting (migration of the electroacoustic part of a musical work from one material system to another) due to a change of the computer environment, new software versions, operating system evolution (etc.) is probably the activity which occupies the most of their time and energy. Consequently, computer music designers have empirically developed knowhow, methodologies and systems to facilitate the porting of works in order to ensure their playability over time. Among these systems, we can cite the Sidney database

developed and hosted at IRCAM (Lemouton 2016), allowing the operational backup of documents created in the institute since its creation in 1977.

Nevertheless, the computer music designers' as well as the instrumentalists' knowledge on how to play a particular work and how it should sound, remain strongly oral and seems to be passed on from person to person. The preservation environment developed at IRCAM is also an attempt to make this knowledge explicit, to transmit and preserve it (through "performance notes", interpretation notes).

Even if the performers have an essential role to play in the transmission of works, preserving the piece for future generations seem not to be their responsibility, and neither is distribution.

Publishers

Traditionally, this role would fall more to music publishers. From the very beginning of musical printing in the Renaissance, publishers have assumed this role of commercialization of the scores and therefore of disseminating works. Unfortunately, during the 20th century, few music publishers realized the importance of the technological developments in musical practice. Historical publishing houses have not equipped themselves to respond to technological developments in the field of digital distribution of music online, and even less to the distribution of works involving hybrid or heterogeneous media. This means that when performers order scores of mixed works, they receive elements of the electroacoustic part, but rarely they receive usable material.

In short, if publishers have the mission of disseminating and preserving the works of composers in their catalog, it seems that they have not given themselves the technical means to do so.

Creation Centers

Many works from the 20th century electroacoustic repertoire have been produced in and/or commissioned by institutions (radio studios, laboratories, research institutes, creation centers, etc.). These institutions, at least some of them, may have the mission of preserving the works created on their behalf.

Institutions are not eternal and when they close their doors, their

archives can disappear. Among the important institutions of the 20th century music history that have disappeared, there are, for example, the studio of the Westdeutscher Rundfunk (WDR) (Hermes 2020) in Cologne, which operated until 2000, or the Institute of Electroacoustic Music in Bourges (IMEB), closed in 2011 (cf. https://misame.org/). Many other important centers have closed, and many archives have been for ever lost when they could not have be saved in extremis by researchers or enthusiasts.

Even in creative centers still in operation, it can be quite difficult to find archives as can be seen for example in the investigative work of Kevin Dahan on the Center For Computer Research in Acoustics and Music at Stanford (Dahan 2018).

During a recent survey (Bonardi 2020), it was observed that works created within the French National Centers of Music Creation were very rarely accessible because they were not archived. This survey shows that the cycle of documentation, storage, and updating involved in the preservation of computer music systems require human and financial resources that the majority of creation centers do not have.

State

The Bibliothèque Nationale de France is the depositary of all that is published or distributed in France:

> *"Established in 1537 by François Ier, 'Depot Legal' allows the collection, conservation and consultation of documents of all kinds, in order to constitute a collection of reference, an essential element of the collective memory of the country. It is conceived as the memory of the cultural heritage disseminated on the national territory and therefore includes foreign works published, produced or disseminated in France."* (https://www.bnf.fr/fr/quest-ce-que-le-depot-legal, last access Aug. 2020)

'Depot Legal' also includes printed music and is suitable for digital media that appeared in the 20th century: legal deposit of audiovisual documents, digital documents, websites (net archives).

National archives based on state institutions and legislative texts (in this case Article L131-2 of the Code du Patrimoine) seem to be the most capable of guaranteeing reliable heritage conservation over the long term. Nevertheless, it must be con-

sidered that the repertoire in question is internatinal. Works created in France can be reinterpreted in other countries, or be the fruit of collaborations between studios and composers of different nationalities.

United Nations

As early as 2003 in its Charter on the Preservation of the Digital Heritage, UNESCO affirmed that

> *"Unless the prevailing threats are addressed, the loss of the digital heritage will be rapid and inevitable. Member States will benefit by encouraging legal, economic and technical measures to safeguard the heritage. Awareness-raising and advocacy is urgent, alerting policy-makers and sensitizing the general public to both the potential of the digital media and the practicalities of preservation."* (UNESCO 2009)

Conclusions

We have mentioned (probably non-exhaustively) various actors owning responsibility regarding the preservation of electroacoustic music works. But it seems that none of them can properly fulfill this mission. We believe that the solution lies in a collective effort of all these actors. This common commitment will not emerge without a unifying project and a common preservation environment. This project must also be based on a perennial institution that can ensure its own sustainability.

We have also identified the difficulties inherent in preserving this repertoire. There are pitfalls to be avoided for the preservation to be effective, and to prevent the historical period we are living through from disappearing in what some authors or historians of the future may call the "digital black hole of the 20th century". Unfortunately, most repertoire preservation initiatives have failed on these pitfalls, as evidenced by the long list of missing projects identified by the AFIM working group. In fact, many preservation projects rely on unsustainable funding or institutional support. This leads to the following paradox: preservation projects fail to preserve themselves and evaporate when the project ends. What I call "metapreservation" is the preservation of the preservation projects infrastructure. It is vital for preservation projects to think from the start of finding technical, financial and human means to ensure their survival.

This goes through the need to build trusted digital repositories as defined in RLG-OCLC (2002).

The need for such structures is urgent, because the longer we wait, the more musical pieces will be lost and the more difficult will be the task of finding or interpreting documents to re-perform the music from the end of the 20th century.

References

Bonardi, Alain et al. (2020). *Archivage collaboratif et préservation créative - rapport final du groupe de travail*. Association Francophone d'Informatique Musicale.

Dahan, Kevin (2018). "(Re)discovering Sounds of CCRMA - Towards Computer Music Preservation", in: *Proceedings of the International Computer Music Conference ICMC*.

Hermes, Ida. (2020). "Was wird aus dem WDR-Studio für elektronische Musik?", https://www.deutschlandfunkkultur.de/eingemottet-in-kellerraeumen-was-wird-aus-dem-wdr-studio.2177.de.html?dram:article_id=468464, last access Aug. 2020.

Lemouton, Serge and Samuel Goldszmidt (2016). "La préservation des œuvres musicales du répertoire de l'IRCAM: Présentation du modèle Sidney et analyse des dispositifs temps réel", in: *Journées d'Informatique Musicale*, Albi, 2016.

RLG-OCLC (2002). "Trusted Digital Repositories: Attributes and Responsibilities".

UNESCO (2009). "Charter on the Preservation of the Digital Heritage," http://portal.unesco.org/fr/ev.php-URL_ID=17721&URL_DO=DO_TOPIC&URL_SECTION=201.html, last access Aug. 2020.

Zattra, Laura (2016). *Collaborating on composition: The role of the musical assistant at IRCAM, CCRMA and CSC*. Routledge Francis & Taylor.

Preserving Hardware History: Archiving the Studios at Columbia University

by Seth Cluett

Otto Luening and Vladimir Ussachevsky began their first academic experiments with studio electronic music in the United States in the early 1950s at Barnard College and Columbia University. Since that time, at what is now known as the Computer Music Center at Columbia University, storage closets and boxes filled with paper files, media artifacts, and numerous pieces of custom electronic equipment have accumulated, which are now in need of preservation and safekeeping. Interlinking histories of people, facilities, and technologies present complex challenges for conventional archival approaches, collection management, and storage. While personal papers of personnel, studio documentation, and audiovisual media fall within established practices for archival collections in the arts and music, the technological holdings—hardware devices unique to each studio—raise a complicated set of questions: What criteria do we use to determine what is kept? Is it important that the devices be in working condition? Should this equipment be refurbished, maintained, or preserved? The RCA Mark II synthesizer, which has been well-documented in the historical literature on electronic music, was just one technology among many participating in a 70-year history of engagement with electronic music at Columbia. By understanding the development and use of hardware assets, custom tools, and bespoke electronic devices, we hope to raise awareness and provide critical evidence for researchers and composers to understand the creative process and technological affordances associated with historical studio practices.

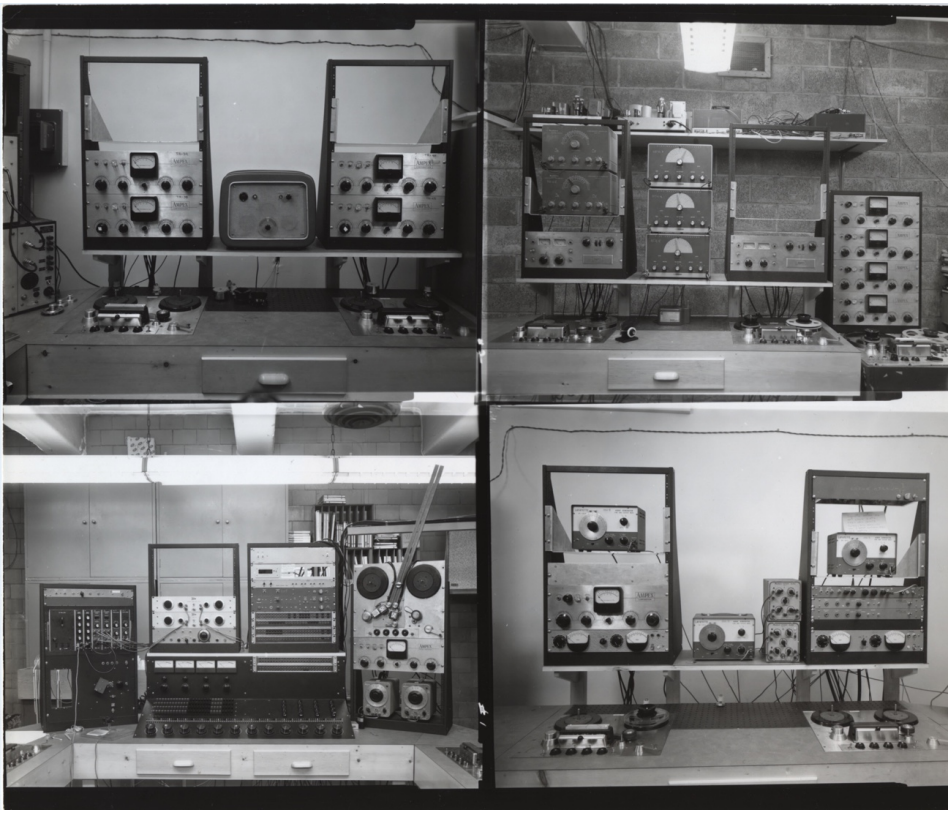
The first formal facility dedicated to sound experimentation on Columbia University's 116th-Street campus in the late 1940s was known as the Columbia Experimental Music Studio; with the acquisition of an Ampex 400 tape recorder in 1951 (Monroe, Mary 1996), it became the Columbia Tape Music Studio. After moving to 125th Street in the late 1950s, the facility grew substantially with the acquisition of the RCA Mark II and the founding of the Columbia-Princeton Electronic Music Center (CPEMC) in 1959 (Gluck 2007). When the collaboration with

Princeton ended in the late 1980s, it became the Electronic Music Center (EMC). In 1996, occupying the same footprint, the facility was renamed the Columbia University Computer Music Center (CMC). Because of the long history, changing locations, and expanding academic and cultural impact of multiple generations of electronic and experimental music facilities at Columbia, archival efforts have focused on saving at-risk paper records and audio and moving image media.

Until recently, the hardware history and documentation surrounding the technical infrastructure have remained largely unaddressed. In the past 10 years, significant work to consolidate archival materials related to the CMC's history have been made through the efforts of Brad Garton, Director, and Terry Pender, former Associate Director, of the CMC. We have worked closely with Elizabeth Davis and Nick Patterson from the Music & Arts Library at Columbia to assess holdings and safely store and transport materials to the Rare Books and Manuscripts Library (RBML) at Columbia's main Butler Library (Patterson 2011). The focus has been to centralize decades of historical materials from each of these facilities, including photographs, paper-based materials, and recorded media. While individual composer archives remain spread out between the New York Public Library for the Performing Arts (NYPL), the Library of Congress (LoC), and other repositories, archival collections related to the CMC facility are now housed at Columbia's RBML, whose music holdings are separate from the main Music Library.

While there are numerous commercial releases of work created at Columbia, these documents represent only a fraction of the work produced in the studios. Very little of the rich early audio history of the studios has been easily accessible, until, in May of 2018, the Columbia University Library was awarded a major Grammy Foundation grant to digitize approximately 400 hours of recorded electro-acoustic work curated from 1000 of the roughly 5500 reel-to-reel tapes in the studio archival holdings (Lovell, Abigail 2020). In July 2020, these recordings were made publicly available in the University's online catalog and published to the Library's Digital Libraries Collection. The recordings reveal hours of pathbreaking experimentation with technology, documenting

the creative process and practice of hardware exploration in the studio. In addition to these audio holdings, 312 linear feet of paper documents, ranging from equipment receipts, budget ledgers, correspondence, manuals, and photographs, remain to be processed. With the highest-risk materials safely cared for, the CMC is now working towards gaining intellectual con-



Equipment racks, oscillators, custom tape machines, Room 324 Prentis Hall, Columbia-Princeton Electronic Music Center (c. 1960). Photographer: Unknown.

trol of the remaining technological holdings in storage in our facility.

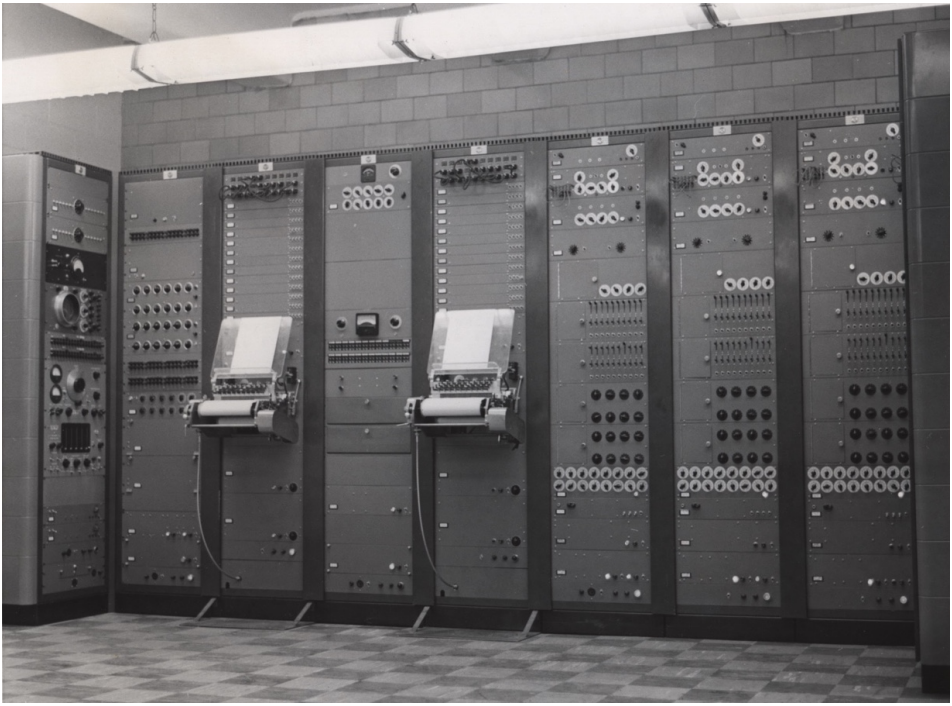
In January 2018, I curated Sounding Circuits: Audible Histories at the New York Public Library for the Performing Arts at Lincoln Center (Cluett 2018). This exhibition explored the networks of composers and engineers—as well as the groundbreaking facilities and revolutionary technologies—that played a crucial role in the expansion of electronic sound from the 1950s to the present. Drawing together primary source materials, including personal correspondence, historical recordings, technical documentation, and musical sketches and scores from across the New York Public Library for the Performing Arts' rich archival collections, this exhibition highlighted the significant contributions of pioneering composers like Otto Luening, Pauline Oliveros, Edgar Varèse, and Charles Dodge to the then newly-developing practices of electronic and computer music during the last century. These materials were placed in dialog with electronic sound processing equipment, oscillators, an early mixing console, a full-scale photographic reproduction of the Columbia-Princeton Electronic Music Center's RCA Mark II Synthesizer, drawn from the archives at Nokia Bell Labs and the CMC.

The wonder, curiosity, and passionate engagement of exhibition attendees encountering early sound experimentation technologies for the first time revealed the urgency of archiving, maintaining, and in some cases, renovating the extant historical equipment stored at the CMC. We have begun the process of stabilizing physical storage, creating an inventory, and assessing the operational viability of technologies ranging from custom mixers made in the early 1950s to one-of-a-kind and rare equalizers and delays from the 1960s and synthesizers and sound processing units from the 1970-1990s. While some devices have been in continuous operation and maintained since they were initially installed, many had been placed into long-term storage as each new incarnation of the facility adopted current, innovative technologies and expanded its resources for creative applications. The CMC is now cataloging, cleaning, and testing stored equipment with the long-term goal of creating technologies to integrate historical pieces into contemporary studio spaces for creative use and

scholarly study.

Many are not aware that the RCA Mark II Synthesizer is still installed at the CMC today. First assembled in Prentis Hall at the founding of the CPEMC in 1959 and in continuous use through the 1960s and 70s, the Mark II has been the subject of hundreds of pages of scholarly writing on electronic music. The Mark II was operational until 2015, when an electrical malfunction caused staff to discontinue its use. Last year, after more than 60 years in Prentis Hall, CMC staff received notice from Columbia University that we need to begin planning for the possibility of relocating the facility. While I am confident that the important work we are doing to gain intellectual control over the hardware history of the Center is valuable and indispensable, this plan would necessitate moving the Mark II - a process which will require additional careful planning, archival research into the operation and design of the technology, and scholarly engagement from electrical engineers, historians, and composers alike.

To that end, we have begun to identify useful materials about the Mark II from the CPEMC archives at Columbia's RBML, including circuit schematics, photographs of modules taken before Columbia received shipment, as well as electronics textbooks and manuals from the time of its design and construction. We have started the process of reaching out to historically-important synthesizer designers, electrical engineers invested in the history of circuit design, former technical directors for the Center, and decades of graduate students who have completed research on the Mark II and its users. Peter Mauzey, who installed the Mark II in 1959 and was both a longstanding staff member of the CMC and on the faculty of Columbia's electrical engineering department, has agreed to participate in an oral history interview and engage our team in a dialog about the original installation, in hopes that his extensive experience might guide its renovation, disassembly, and reassembly. We plan to make all of these materials publicly available so that scholars, students, and practitioners can engage actively with the renovation process. By sharing schematics, images, design documents, and manuals, alongside conversations, annotations, and collaborative brainstorming, we aim



RCA Mark II Synthesizer, Room 317 Prentis Hall, Columbia-Princeton Electronic Music Center (1959). Photographer: Unknown.

to leverage the archival holdings of the Center as a catalyst for stimulating future engagement with the discipline. We hope that this process can serve as a model for linking the technological history of electronic and computer music with the paper, audio, and moving image holdings so robustly represented in archival holdings for studios worldwide, to better understand the role played by material conditions on the formation of individual creative work and communities of practice.

References:

Cluett, Seth (2018), "Sounding Circuits: Audible Histories", *The New York Public Library,* 2018. www.nypl.org/events/exhibitions/sounding-circuits-audible-histories, last access Sept. 14, 2020.

Gluck, Robert J. (2007), "The Columbia -Princeton Electronic Music Center: Educating International Composers", *Computer Music Journal* 31 (2): 20–38.

Lovell, Abigail (2020), "Libraries Digitizes Columbia-Princeton Electronic Music Center Collection", 2020. https://blogs.cul.columbia.edu/spotlights/2020/07/29/columbia-princeton-electronic-music-center-collection/, last access Sept. 14, 2020

Monroe, Mary (1996), "Music at Columbia: The First 100 Years", *Music at Columbia: The First 100 Years*, 1996. https://exhibitions.library.columbia.edu/exhibits/show/music-centennial/electronic-and-computer-music, last access Sept. 14, 2020.

Patterson, Nick (2011), "The Archives of the Columbia-Princeton Electronic Music Center", *Notes* 67 (3): 483–502.

The Electro-Acoustic Music Mine Project (EAMM). Collecting, Archiving, Sharing, and Exploring

by Tae Hong Park

Introduction

Electro-acoustic music (EAM) is a technology-driven genre of art music that began to develop during the 1950s. With the advent of the computer, the field of EAM has since grown significantly. EAM has established itself, in avant-garde and academic communities, as a significant field of artistic creativity, research, and intellectual inquiry that includes composers, performers, scholars, researchers, engineers, scientists, and music practitioners. Due to the very nature of this work – including its heavy reliance on new technologies, multi-format audio files, idiosyncratic scores, computer code, and schematics that describe complex performance setups – an appropriate and reliable method of preservation is needed. For EAM, there are currently no such preservation systems that can effectively preserve the musical works and the software systems, models, and knowledge that engendered those works. Although many of such works are presented, performed, and temporarily stored

during the submission, review, and production phases of conferences where such works are typically presented, once the event is over, artifacts are relegated to physical and digital attics of the organizers. The EAMM project aims to take advantage of existing conference music collection workflows that loosely resemble music curating and archiving practices in an effort to collect, archive, share and create portals for exploring EAM.

Motivation

EAM is typically presented in academic settings including conferences and music festivals. Upon conclusion of the conferences, however, both the music and attendant data are either lost, or if archived, very difficult to access and "slowly disappearing" (Cuervo 2009). In cases when fragments of archived data do exist, they remain typically offline, making access difficult for researchers, and virtually invisible to the average information seeker. Two of the most significant EAM conferences are the International Computer Music Conference (ICMC) and the Society for Electro-Acoustic Music in the United States (SEAMUS) conference. Every year, ICMC and SEAMUS program approximately 200 (~12% acceptance rate) and 100 (~20% acceptance rate) works respectively. Each conference produces a single audio CD with about eight works each: 90% to 95% of works presented at the conferences are lost. Since the inception of these organizations, both conferences have utilized vigorous peer-review procedures (developed over the past 40+ years) to curate the "best" pieces for presentation. An estimated 7,000 ICMC and 2,500 SEAMUS works have been lost, or are at best, inaccessible, since the establishment of the conferences in the mid-1970s.

The mere fact that this music from a cadre of significant international composers (conveniently provided and stored digitally at conference databases at the curating phase) is being lost is an issue in itself. Concerns are further heightened as the music being lost
(1) has significant musical and cultural value and is of historical importance,
(2) plays a central role in contributing, informing, enriching, and expanding our experience of contemporary musical thought and
a diverse musical heritage, and

(3) has little chance of being available for general public programming as musical traces are erased after the completion of events.
Internationally recognized composers typically create much of this music, but it does not readily fit into existing music industry models and preservation mechanisms. This situation resembles highly theoretical scientific research papers, which oftentimes yield no immediate and practical application and neither seek recognition from industry, nor aim to be financially successful. The difference is that for such research, reliable preservation models do exist.

Preservation in itself, however, is just part of the problem; the materials have to be both archived and accessible. Conferences that temporarily create databases with complicated access mechanisms are designed for review purposes; as such, they not only severely limit and discourage access, but also negate the fundamental purpose of such digital archives – to allow the general public to explore, learn, and utilize materials for research, education, or to simply facilitate the enjoyment of art. There are also more "inspirational" reasons for providing access to EAM. For example, there is the case of popular music group Radiohead, who created one of their most successful songs *Idioteque* (2000) after fortuitously coming across Princeton University Professor Paul Lansky's EAM composition mild und leise (1975). According to Lansky:

> *"The piece [mild und leise] came out on a Columbia/Odyssey LP in 1975 or so as a result of a contest run by the International Society for Contemporary Music (ISCM). It was called Electronic Music Winners (I've occasionally seen it for sale on Ebay), and Jonny Greenwood [one of Radiohead's songwriters] came across it in a used record shop when the band was on tour in the United States recently. I think it sold about 7,000 copies, which is a lot for a classical recording."* (www.music. princeton.edu/paul/radiohead.ml.html, last access Sept. 14, 2020)

Radiohead has sold well over 30 million records in total. There are, of course, other interesting examples where EAM has had considerable artistic influences on popular music cultures. For the band Matmos, EAM became influential upon their discovery of musique concrète techniques,

which they have adapted as a fundamental fabric of their music – utilizing everyday sounds via standard recording devices. It is no coincidence that both band members, Drew Daniel and Martin Schmidt, have their roots in academia and are also well versed in the history and literature of *musique concrète* (Daniel is currently a professor of English at Johns Hopkins University). For Frank Zappa, the shaping of his music was also highly influenced by EAM. His exploration of art music seemingly began when he found the album *The Complete Works of Edgard Varèse*, Volume One after a year-long LP searching quest (Zappa and Occhiogrosso 1989). Towards the latter part of his career, Zappa focused much of his signature work around the Synclavier, a digital sound synthesizer developed by Dartmouth College EAM composer Jon Appleton. In another celebrated example, the Beatles wrote their infamous "sound collage piece" *Revolution 9* after being exposed to the works of Edgard Varèse, Karlheinz Stockhausen, and Yoko Ono (MacDonald 1994; Sheff 2000). The distinctive artistic and musical paths of all these artists could have been very different (perhaps for the worse) if they had no access to an esoteric EAM resource, whether by chance or whether being in a privileged position of access. The affective impact of EAM that ignited innovation and creativity amongst these prominent musicians, and its contribution of musical culture, is immeasurable.

The affective role that EAM has had is not only found in artistic and musical spaces. Due to the multidisciplinary nature of EAM, innovative research and development, and creation of new technologies are also key aspects of its very existence. Technological innovations are often originally expressed in, and tightly coupled to, the compositions themselves and documented in concert program notes. A plethora of examples exist including pioneering research and development of sound recording techniques with early tape recorders, invention of musical synthesizers, and the first computer language created by Max Mathews who is widely regarded as the grandfather of computer music. An especially impactful example of this cross-disciplinary narrative can be found in EAM composer John Chowning's invention and patenting of frequency modulation (FM) sound

synthesis. In 1994 FM was the "second most lucrative licensing agreement in Stanford's history" (http://news.stanford.edu/pr/94/940607Arc4222.html, last access Sept. 14, 2020).

Existing Models for EAM Preservation

There are a number of existing EAM preservation models today, including professional archival services, commercial recordings, artists' personal websites, and other Internet-based sites. Artist websites are ubiquitous but have limitations as preservation models
(1) distribution: sites are randomly spread over the Internet;
(2) sustainability: hosting is often temporary and maintained by the artist; and
(3) accessibility: the user has to sift through an ocean of data as the great majority of music recommendation research in MIR is focused on popular music.
Few record labels publish EAM at all, and the ones that do operate within a framework of economic viability, which can be at odds with artistic merit. This typically involves a curating system that can also be at times sensitive to political factors and inherent biases due to practicalities that may are not necessarily a function of artistic or cultural significance.

Existing "professional" EAM-related archives include the Digital Anthology of Recorded American Music (http://www.dramonline.org, last access Sept. 14, 2020), International Electro-Acoustic Music Archives (http://on1.zkm.de/ zkm/e/institute/mediathek/ideama, last access Sept. 14, 2020), and Ubu-Web (http://www.ubu.com, last access Sept. 14, 2020). DRAM is a non-profit resource (paid subscription) with 3,000-album archive of recorded American music, including some EAM. The anthology is compiled from recordings provided to DRAM by independent record labels. Although DRAM is a valuable resource for new music and EAM, it is worth noting that it is limited to American music recordings and works already available through record labels. The limited repertoire is the most significant issue – searching the DRAM anthology for EAM pioneers John Chowning, Max Mathews, and Barry Truax yields no results, for example.
A second archive, IDEAMA was created in 1988 in an effort to preserve the "most endangered early [EAM]

works" up to around 1970. In 1990 the project developed into a collaborative project between Stanford University and the Zentrum für Kunst und Medientechnologie Karlsruhe (http://on1.zkm.de/zkm/e/, last access Sept. 14, 2020); 570 works, selected by an "international advisory board," are now archived. These are valuable collections in MP3 format. The database, now maintained by ZKM, has grown since the 1990s to include newer EAM works under the <mediaartbase.de> framework. Limitations of the IDEAMA archive include the fact that the collection only catalogs works up to 1970. The extended ZKM archives include either self-submitted contributions or entries curated through ZKM. UbuWeb is a repository that went online in 1996 with much contemporary avant-garde music, including EAM. As a do-it-yourself initiative, it is unsupported by any institution or industry partner, and although it is easily accessible on the Internet now, it falls short as a preservationlevel archival resource owing to uncertainties about its sustainability, audio quality standards, and curation process. According to their website, "UbuWeb posts much of its content without permission; we rip out-of-print LPs into sound files; we scan as many old books as we can get our hands on; we post essays as fast as we can OCR them."(http://www.ubu. com/resources/index.html, last access Sept. 14, 2020) YouTube, in the present context, could be considered a gigantic, crowdsourced version of UbuWeb. As preservation repository, however, it fails to measure up with respect to audio quality (often substandard), stability of its content (here today, gone tomorrow) and intellectual property management.

The EAMM Preservation and Archival Model

Multiple concerns exist in current EAM preservation and archival models. These include:
(1) the lackof established practices that are sustainable, expandable, scalable, and diverse;
(2) the absence of internationally accepted peer-reviewing standards;
(3) the absence of an agreed-upon EAM metadata standard; and
(4) the limited accessibility to archives through modern technologies.
The Electro-Acoustic Music Mine (EAMM) model attempts to contribute in addressing the aforementioned concerns. EAMM attempts to enhance and contribute to, rather than replace,

existing technologies and models of digital archiving methodologies. In establishing protocols that are effective, efficient, sustainable, and scalable, EAMM attempts to address issues concerning peer-reviewing, metadata standards, technological currency, interface design, development of transferable technologies, scalability, the building of low-risk structures, and adaptability to changing digital archive environments.

Structurally, EAMM comprise of three modules at various development stages:
(a) the filtered crowdsourcing module (FCS),
(b) the archive/preservation (AP) module, and
(c) the content-based analysis (CBA) module.
The FCS module provides a streamlined crowdsourcing model for data collection that is subjected to a "credentialed filtering" process via peer-reviewed jurying. "Filtering" the crowd-sourced submissions provides a mechanism for selecting the most significant works as determined by an internationally recognized peer-reviewing system. This mechanism helps to control the number of works we can reasonably archive, as it is impractical, infeasible, and undesirable to archive every submitted work. The AP module consists of the archival database that contains all media data, metadata, and any other data associated with a composition, including performance and performer history. Lastly, the CBA module provides a baseline platform for the development of next generation exploration interfaces of the EAMM archives by utilizing digital signal processing (DSP), visualization techniques, and music information retrieval (MIR) as further described below.

We are currently working with NYU Libraries and the International Computer Music Association (ICMA), and the New York Electro-Acoustic Music Society (NYCEMS). ICMA, in particular, has a preeminent international reputation in the field for its sponsorship of annual EAM conferences since 1974; and there is ample evidence through these 46+ years of experience that ICMA conferences will continue to strive and attract the best EAM works for the foreseeable future. At the same time, the cultural value of EAM extends far beyond the academic community alone and we hope that academics, music enthusiasts and the general public will benefit

from EAMM outputs which will ultimately include:
(1) a permanent, sustainable, and expandable EAM preservation repository housed at the NYU Library;
(2) interfaces for discovery and interaction with the material; and
(3) access to otherwise unavailable EAM resources including audio files, metadata, computer code, digital conference booklets, details about a composition, performance history, and musical scores.

Retroactive Archival Efforts

To lay the foundation for EAMM, we will build a historical archive that will salvage what is left of the recordings and related data for works presented at the ICMC conferences – including high quality recordings and concert performances whenever available – up through 2020. We have thus far secured the 2011, 2012, and 2018 datasets and are working on collecting the 2020 dataset. The retroactive collection program will not only preserve this important legacy, but it will also contribute in developing and tuning our EAM metadata set by researching and analyzing metadata structures used in the conferences. We anticipate that this, in turn, will greatly contribute towards creating an inter- nationally recognized EAM metadata standard. For the retroactive initiative we will use the camera-ready FCS sub-module – interface used to collect conference accepted data – to streamline and crowdsource the collection of archival quality media files, additional metadata, and other data types that we have identified as necessary for our EAM metadata schema.

Intellectual Property and Author Permissions

Since our EAMM collection is international in scope, aim for its accessibility is to be as open as possible. The level of restriction for access to the material can be, however, individually modulated according to each contributing artist's preferences depending on enduser types: general public or individuals who formally apply to us as researchers, for example. Other mechanisms that we are considering is access limited to those physically on the premises. All works is accompanied with authorial permission and all rights of the archived works in our EAMM database will remain with

the author. Each submitter to the ICMC conference is provided with a digital agreement form where authors can choose to participate in archiving their works. As EAMM's collection mechanism is primarily based authorial crowdsourcing paradigms, intellectual property, copyright, and licensing issues are greatly simplified, and the EAMM archive (by virtue of its metadata structure) will itself be the place where intellectual property (IP) agreements with authors are documented.

Conclusion

EAM explores and pushes artistic, aesthetic, and technical boundaries and is typically presented by specialists at academic conferences. Unlike the majority of popular music, it is not economically-driven, nor reliably preserved by market mechanisms or archival projects sponsored by industry, libraries, or museums. Furthermore, all of the EAM data that is carefully and painstakingly collected is typically lost after a conference concludes. When and if the music is archived, the burden to create a preservation system falls on conference organizers unprepared to build and maintain a dependable archive. The physical inaccessibility of EAM for the expert and wider audience is an issue in itself as its current outlet mechanism limits its exposure to the academic community, which in turn inhibits growth in musical diversity and the wider aesthetic and pedagogical potential for the general public. The musical inaccessibility further diminishes accessibility of this work to a greater audience, a problem exacerbated by inadequate exploration platforms for "art music" in general. These factors contribute to the difficulty of fitting EAM to existing preservation models. The Electro-Acoustic Music Mine (EAMM) attempts to address the aforementioned issues by creating an EAM preservation and exploration portal based on:
(1) a semi-automated crowd-sourced music collection module curated through credentialed peer-reviewing systems,
(2) a comprehensive archival and preservation module, and
(3) an analysis module based on the timbre-centric Electro-Acoustic Music Analysis (EASY) Toolbox providing an online platform for interactive visualization, navigation, and discovery of EAM.

This third module exploits Music Information Retrieval (MIR) and content-based analysis baseline to extend and enhance traditional text-based indexical discovery and delivery systems. No similar credentialed, peer-reviewed preservation system exists for EAM, and no MIR-based EAM exploration interfaces exist for any kind of music archival system.

References

Cuervo, Adriana P. (2009). "Ephemeral music: Electronic music collections in the U.S." in: *Proceedings of the Society of American Archivists' 2008 Research Forum - Foundations and Innovations.*

MacDonald, Ian (1994). *Revolution in the head: The Beatles' records and the sixties*. New York: Henry Holt.

Park T. H, Zhiye Li, and Wen Wu (2009). "EASY does it: The Electro Acoustic Music Analysis Tool." in: *Proceedings of the International Conference on Music Information Retrieval* (ISMIR).

Park TaeHong, et al. (2010). "SQEMA: Systematic and Quantitative Electro-Acoustic Music Analysis." in: *Proceedings of the International Computer Music Conference ICMC,* New Yorks 2010.

Park Tae Hong, et al. (2011). "Towards a comprehensive framework for electro-acoustic music analysis." in: *Proceedings of the International Computer Music Conference ICMC*, Huddersfield 2011.

Park, Tae Hong, et al. (2014). "Towards Soundscape Information Retrieval (SIR)." in: *Proceedings of the Inter-national Computer Music Conference Proceedings ICMC*, Athens 2014.

Teruggi, Daniel (2007). "Technology and musique concrète: The technical developments of the Groupe de Recherches Musicales and their implication in musical composition." *Organised Sound,* 12(3): 213–231.

Zappa, Frank and P. Cocchiorosso (1990). *The real Frank Zappa book*, Touchstone, pp. 30–33.

Musings on computer music perennity

by Kevin Dahan

Introduction

It should come as no surprise that, at more than sixty years of age, the computer music field starts to ponder its legacy: what started almost as a 'challenge' (Chasalow, 1998) is now a well-established academic practice which has had a profound impact over the whole music and entertainment industries. More often than not, breakthroughs in our field were initially established through pursuing musical or aesthetical, rather than purely technical, goals: this is especially the case in 'early' computer music. Clearly, it is now time to reflect on the numerous techniques (many of which make the foundations of current music software) that have been initiated over the years. Perhaps one of the best ways of examining these is through in-depth multimodal analyses of computer music works: this approach would constitute an initial effort towards a critical evaluation of computer music history. However, for a long time, composers, researchers and institutions did not have the means to store anything beyond the output of the computing process, losing essential information on the means of production. On top of that, the deterioration of media on which these compositions were recorded and stored is a known issue which has been acknowledged and partially addressed since the 1990s (Bauman, Diener and Mathews, 1991; Goebel, 2001; Battier, 2004). Since the mid-2000s, more initiatives emerged to safekeep early computer music masterpieces using reengineering techniques, often prompted by the rediscovery of compositional sources (Zattra, 2015): unfortunately, while important sources may still exist somewhere in one form or another, extensive documentation is quite hard to come by. Currently, there are initiatives to document, archive, preserve and present important computer music works being set up in many research centers worldwide. This article posits that understanding the history of our field and critically evaluating its findings from a musical perspective will guide preservation efforts more effectively. It is also through the integration of technological advances made in data science and machine learning that long-term preservation

of computer music will be a reality. Hence, this article proposes a three-step approach to computer music preservation: frame computer music theory, consider its ecosystem, and assimilate newer technologies.

Computer music technologies

Digital technology has this innate quality of potentially being extremely malleable, leading to novel and singular properties in artifacts created through its means. In computer music, the most obvious examples are of course digital synthesis techniques (Smith, 1991), which are central to the computer music composition process. From additive to granular synthesis, and from waveguide to adversarial neural audio synthesis, numerous algorithms were used in compositions to strikingly different end results (FM synthesis, for example, is especially flexible with regard to the wide range of possible sounds achievable with a single algorithm). However, it is interesting to note that, since the initial efforts of Jean-Claude Risset (Risset, 1969), there has been no work undertaken to establish an expanded catalogue that would provide baseline 'recipes' using the multiple synthesis algorithms developed thereafter. Likewise, there has been little effort to establish a working typology with the musician in mind: rather, the referencing of these techniques is primarily done through technical descriptions, which may prove problematic (and lead to confusion) for the non-technically proficient music analyst, or for future generations, for which the technological environment will be largely different. It is already the case: the concept of non-real-time sound synthesis – let alone that of time-sharing on mainframe computers… – is remote to many current students.

Framing computer music theory

This constitutes the first step we need to take towards computer music preservation: (re-)invest in establishing a working musical framework of computer music theory, which would take precedence over and guide technological developments. This is, essentially, going back to the roots of computer music to reevaluate what has been produced in terms of techniques, notably over the past thirty years of computer music: this, incidentally, corresponds to the densification of personal computing, which saw

composers and researchers move away from mainframes to personal, then mobile, computers.

Computer music ecosystems

Another possible approach is to consider computer music production process as ecosystems, which needs to be preserved. Instead of examining, cataloguing and labelling the musical artifacts created through technologies – which is what music analysts mostly do – the focus switches back to the production chain. An initial impulse would be to consider storing the production means of the composition process (e.g. hardware and software), but then we would be losing these technologies altogether. An interesting alternative to this 'cold' storage is to develop emulation of working environments, while we still have access to sufficient documentation. This has been done, for example, for the Samson Box (Schottstaedt and McNabb, 2012; Loy, 2013), which however needs binary .SAM files to work. This exemplifies the ecosystemic approach that has to be followed when considering preservation of computer music: it is simply not sufficient to safekeep and store previous technologies, it has to be preserved in working order, along with surrounding documentation and data. From there, two ways are possible, each requiring a different skillset:
a) adaptation, where a computer music work is 'transcribed' to a new environment, and
b) virtualization, where the environment is emulated. Both approaches' aim is the reconstruction of the original work (Dahan, 2007), but with different means and results. In both cases, extensive data and documentation are needed, and access to the original (and working) creative environment would tremendously help the efforts.

Consider computer music ecosystem

This constitutes the second step: to achieve effective computer music preservation, we need to consider the whole ecosystem in which music research takes (or took) place: production means (including, but not limited to, computers, controllers, operating systems, software), products (e.g. tests, compositions), but also by-products (e.g. documentation, sketches). Of course, an established framework of available techniques, both at the time of the original creation and at the

time of the recreation, is needed, highlighting the importance of a properly framed computer music theory.

Conclusion: towards computer music perennity?

We all have witnessed that the many technological mutations experienced over the last seventy years did not provide a large amount of direct protection to computer music works: hardware were abandoned, software evolved, data misplaced, and as a result, compositions and musical works have been lost. However, we are now living in an age of mature digital technology: the resources, techniques, and more importantly, the perspective we have gained on digital obsolescence, allow us to contemplate the preservation of our field less as an emergency and more as a focused, selective, and informed exercise. Obviously, urgent actions are still needed: data sources need to be found, recovered and transferred to better media for medium term purposes. However, there is some time to plan and develop strategies for the long-term preservation – perennity – of computer music.

Integrate newer technologies

This constitutes the third step: to integrate the latest technological developments and make use of them in the process of preservation. Since an established framework and sufficient multi-modal data would be available, it will make sense to use machine learning techniques to develop appropriate storage approaches, to design functional virtualized environments, or to achieve reconstructions. Ultimately, it could help bridge the gap between musical perception and computing techniques by – circularly – enhancing and refining both the theoretical framework and associated techniques.

And perhaps, along the path of preserving its legacy, it would paradoxically help us discover new ways of achieving what computer music is about: expressing inherently human emotions and feelings through machines and algorithms.

References

Battier, Marc (2004), "Electroacoustic Music Studies and the Danger of Loss", *Organised Sound* 9 (1), pp. 47–53.

Bauman, Marcia L., Glenn R. Diener and Max V. Mathews (1991), "The International Digital Electroacoustic Music Archive", in: *Proceedings of the International Computer Music Conference ICMC*, Montreal 1991, pp. 501–4.

Chasalow, Eric (1998), "The Video Archive of the Electroacoustic Music".

Dahan, Kevin (2007), "Reconstructing Stria", in: *Proceedings of the International Computer Music Conference ICMC*, Copenhagen *2007*, pp. 165-168.

Goebel, Johannes (2001), "IDEAMA – The International Digital Electroacoustic Music Archive", *Journal of New Music Research* 30 (4), pp. 375–80.

Loy, D. Gareth (2013), "Life and Times of the Samson Box", *Computer Music Journal* 37 (3), pp. 26–48.

Purwins, Hendrik, et al. (2019), "Deep Learning for Audio Signal Processing", in: *IEEE Journal of Selected Topics in Signal Processing* 13 (2): pp. 206–19.

Risset, Jean-Claude (1969), *An Introductory Catalogue of Computer Synthesized Sounds*, Bell Telephone Laboratories: Murray Hill, N.J.

Schottstaedt, William G., and Michael McNabb (2012), "Samson Box Emulation Software". https://github.com/mmcnabb/sam, last access August 2020.

Smith, Julius O. (1991), "Viewpoints on the History of Digital Synthesis", in: *Proceedings of the International Computer Music Conference ICMC*, Montreal 1991, pp. 1–10.

Zattra, Laura (2015), "Génétiques de La Computer Music", in: *Genèses Musicales*, Presses Universitaires de Paris-Sorbonne: Paris, pp. 213–38.

Preservation strategies for mixed music: the long tail and the short tail

by Guillaume Boutard

Introduction

I have recently argued (Boutard 2019) that preservation of digital technology in mixed music should build upon the work done for the past ten years in digital preservation in relation to cultural heritage institutions, namely libraries, archives and museums (LAMs). From this premise, I have discussed several hypothetical directions based on a broad and widely discussed distinction between three levels of preservation: bit-level preservation; logical-level preservation; and conceptual-level preservation. The goal of such a paper was to emphasize the similarities in the management of digital objects among various cultural heritage institutions at each one of these levels, whether these institutions manage complex objects (e.g. museums), research data (e.g. academic libraries), or more generic digital artefacts (e.g. archives).

The promotion of Findability, Accessibility, Interoperability, and Reusability (FAIR) as well as Transparency, Responsibility, User focus, Sustainability and Technology (TRUST) is now a fairly widespread theme in research data management and digital archiving (Wilkinson et al. 2016; Lin et al. 2020). These notions provide an overarching frame for best practices in each domain.

Discussing these notions may entail shifting the discussion from similarities to differences between the preservation of mixed music and the preservation of digital collections, archives and new media art pieces. In this paper, I would like to point at these differences and to continue the discussion about the conceptual level of preservation in relation to documentation methods.

Repositories

Tools

Across institutions, a focus has emerged on the analysis of ingest and pre-ingest phases of curation lifecycles, leading to the development of complex digital forensics software distributions such as BitCurator. Molenda (2020), in her recent survey of practices among twenty-seven dutch heritage organizations with a digital repository, reviews sources

including "archive creators (such as governmental institutions, other institutional or private actors), suppliers (for example publishers, broadcasting organizations or radio stations), makers (artists, researchers)" (p. 12). The survey focuses on the use of tools during pre-ingest and ingest because it is not part of 'end-to-end' digital preservation solutions and it is underspecified within the Open Archival Information System (OAIS) model (pre-ingest being completely outside the model). Pre-ingest emphasizes the lack of standardization among producers in terms of file formats, complex objects aggregates, and metadata production: "only about a third of the interviewed heritage organizations can set requirements and therefore has influence on how the collections they receive are prepared and delivered" (Molenda 2020, 13). These issues are well-known in our context of creative practices with digital technologies where the breadth of technology-laden practices may seem overwhelming (arguably less than in the context of digital artefacts collected by museums). The link between repositories and producers is thus critical and relates to the ability to foster best practices.

Molenda (2020), continues: "[...] as much as 64 percent of the respondents reported that they only have partial influence and cannot set hard requirements, and 9 percent reported that they are not in the position to set any requirements at all" (p. 13). To my knowledge, no digital preservation tools – that is to say, within the set currently provided by the digital preservation community and used by LAMs, whether at the 'end to end' digital preservation system (DPS) level or in relation to the broad range of phase-related tools documented in projects such as Community Owned Digital Preservation Tool Registry (COPTR) and Preserving digital Objects With Restricted Resources (POWRR) – are used in relation to mixed music preservation (at any level of preservation). Arguably and to a certain extent, this absence of digital preservation tools in current preservation and curation practice for mixed music relates to the inability to set hard requirements.

Contributors

In a less recent publication (Boutard 2018), I advocated for the broadening of stakeholders in digital preservation of mixed music – building on a previ-

ous study (Plessas and Boutard 2015) – including live electronics musicians (LEMs) in relation with participative repositories. This idea comes from the acknowledgement that we have seen many preservation initiatives coming directly from practitioners (often from performers) during the last twenty years in terms of, primarily, migration of contemporary works which do not make it to any kind of repository and thus disappear from the scope of cultural heritage and best practice in digital preservation. It also builds upon Plessas and Boutard's (2015) definition of interpretation by LEMs of a work, which includes practices relating to adaptation to performance context, debugging, or updating to state-of-the-art technological environnement. The academic history of mixed music preservation is built upon use cases and yet these use cases also fail to be part of the sustainable technological trajectory of mixed music.

The inclusion of multiple contributors or stakeholders in the production of digital expressions (according to the definition of expression in the Functional Requirements for Bibliographic Records - FRBR model) of a mixed music work brings a complexification of preservation management. The relevance of version control systems (VCS) for digital preservation has gained research attention in relation to software heritage, but also limitations: "[...] the task of long term preservation cannot be assumed by entities that do not make it a stated priority: for a while, preservation may be a side effect of other missions, but in the long term it won't be" (Di Cosmo and Zacchiroli 2017, 3).

In their comparative analysis, Barok et al. (2019) show the use of CVS for complex artworks preservation along four categories, which they relate more or less precisely to the OAIS model, namely
1) file and storage management,
2) metadata and provenance,
3) context, presentation, curation, and
4) collaboration and usability.
They further discuss the elements lacking in CVS environments, in relation to their four categories, for digital preservation best practice. As Barok et al. (2019) bring up, as a premise, "[...] it is generally acknowledged that existing digital archiving and documentation systems used by many museums are not suitable for complex digital artworks" (p. 94). Still, current practice in notable institutions such as the

MOMA or the Tate Gallery show how museum are able to connect digital preservation best practice and tools and the management of complex digital artworks. Merging these approaches with VCS principles (which are already part of collection management systems for new media arts to some extent, this should come as no surprise) seems inevitable as far as mixed music (re-)production is concerned. The emphasis. I would argue, should be on provenance, context, and usability.

Strategies

Short tail or long tail

Not all works face the same preservation risks. Lemouton (2012) exposed it clearly:

> *"[...] si l'on veut qu'un répertoire puisse se constituer et faire histoire, il faut avant tout qu'il puisse être conservé dans un temps assez long avec la possibilité d'être rejoué sans trop de difficulté, [...] et comme on ne peut pas prédire quelles seront les oeuvres qui 'feront répertoire', soit il faut tout préserver et c'est trop coûteux, soit on ne fait rien, et alors il n'y a plus aucune chance que cela devienne un répertoire"* (p. 77).

If preservation needs to build upon its communities of practice and be grounded in production workflows, then we need to make a distinction between the short tail and the long tail of performance distributions for mixed music works. Plessas and Boutard's (2015) study of the historical performance trajectory of Philippe Leroux' *Voi(Rex)* is one of the few longitudinal studies of mixed music performance (another one would be Akkermann 2017). They tracked about forty concerts from 2003 to 2015, with four versions of the software (see Boutard 2018) that are registered in the repository at Institut de Recherche et Coordination Acoustique/Musique (IRCAM). *Voi(Rex)* is part of the short tail, that is to say these pieces that are already part of the repertoire, pieces that are played on a regular basis and therefore are migrated to up-to-date software environments. However, not all mixed music pieces are as successful in terms of performance rate for multiple reasons, for example the complexity of the production process or the reputation of the piece.

The second part of the performance rate distribution is the most at risk, that is to say the long tail, those

pieces that are not played at a sufficient rate. When the rate of production and performance falls below the schedule for major version update of software development environments, technological obsolescence becomes more prevalent to the point where migration becomes a more difficult strategy to apply (putting aside the supplementary question of expertise) without the preservation of the original technological environment. At this point, the strategy changes from the preservation of the work's implementation to broader software preservation strategies.

The growing interest in software preservation led to several initiatives, such as the ones already mentioned (see Di Cosmo and Zacchiroli 2017) as well as more global strategies like the software preservation network (Meyerson et al. 2017). Software is now collected either for digital forensics, digital archeology or digital preservation – for example, the National Software Reference Library (NSRL) at the US National Institute of Standards and Technology (NIST). The question of fair use in relation to software preservation is a core element of these strategies, as emphasized by the US association of research libraries: "one of the most persistent challenges to software preservation has been legal uncertainty. Practitioners fear that legal structures developed to regulate software in the commercial marketplace (like restrictive licenses and so-called 'anti-circumvention' rules) somehow may impinge on their work. They also know that core preservation activities almost inevitably do trigger copyright concerns" (Aufderheide et al. 2019, 2). Legal battles around circumvention for software preservation are exemplified in the US by the temporary exemptions to the Digital Millennium Copyright Act (DMCA) provision by the Library of Congress.

With the advent of software libraries and the maturing of emulation on demand, we may also have applicable strategies for the long tail. Indeed, we can now think about emulation (not virtualization) as an access strategy, which can support migration when funds or human ressources are available. Rather than migration triggered by the monitoring of technological obsolescence, the more realistic idea of migration on request could support the long tail. This strategy requires a participation

of the music technology community in the development of current and future software libraries (These software libraries are about software environments required for running the pieces and must include commercial solutions. They are independent from the repositories needed for the archiving of the pieces themselves). The preservation of the long tail is also, primarily and the most directly, the part of the repertoire requiring the broadening of contributors that we emphasized in the previous section. Institutions holding digital repositories do not have additional resources for complex pre-ingest in relation to this part of the repertoire but they may support semi-automatic ingest and archiving with minimum costs and expertise needed.

Documentation

As Escobar Varela and Lee (2018) put it, in the context of performance archives : "however, there are still relatively few archives and many of them are not yet equipped to realize the full potential of digital documentation; they have been slow to adopt standards for data reusability, findability and interoperability" (p. 17). Several proposals have been made for documentation of mixed music, either at the conceptual level or the logical level (e.g. Boutard 2019), most of them discussing methodological propositions to capture knowledge of human agents relating to the creative processes, whether from a compositional or interpretational perspective. In parallel, proposals for software-related preservation exacerbate context : "ideally, one might want to archive software source code 'in context', with as much information about its broader ecosystem: project websites, issues filed in bug tracking systems, mailing lists, wikis, design notes, as well as executables built for various platforms and the physical machines and network environment on which the software was run, [...]" (Di Cosmo and Zacchiroli 2017, 4). A significant part of these elements may be automated during pre-ingest/ingest (I think specifically about automatic analysis of patches and, in parallel, a significant part could rely on generic functionalities of the CVS) and the remaining elements should be included in future hard requirements.

On the other hand, it is worth noting that museums have recently put

specific efforts in the documentation of immersive media artworks. One example of these projects is Preserving Immersive Media at Tate Gallery, which started in 2018. I would argue that these projects and their outcomes are relevant for mixed music preservation. Based on this idea, in 2020, we started the project Sound Art Documentation: Spatial Audio and Significant Knowledge (SAD-SASK), funded by the Canadian Social Sciences and Humanities Research Council (SSHRC), in collaboration with museum conservators and academics specializing in sound art and/or spatial audio in North America and Europe. SAD-SASK aims at investigating the relevance of state-of-the-art spatial audio capture and virtual environment rendering technologies for the documentation of sound art. The goals are to:

1) identify significant knowledge associated with sound art installations with an emphasis on sensory experience;

2) specify best practices for documentation of sound art beyond technical specifications; and

3) acknowledge the relevance and benefits of cross-fertilization of expertise to conservation processes for sound-art installations.

SAD-SASK builds on the work of Boutard on tacit knowledge documentation and Guastavino's work on sensory experience of complex auditory scenes and perceptual evaluations of spatial audio (Boutard and Guastavino 2012; Guastavino and Katz 2004; Tarlao, Steele, and Guastavino 2019). In terms of stakeholders, the project targets not only sound artists but also time-based media conservators and curators, and sound engineers. Building a documentation framework for sound art may benefit installation and curation processes but also analysis as well as dissemination to a larger public.

The methods coming from such projects may be injected back in the preservation of mixed music which faces similar questions of documentation in relation to technologies and room acoustics as well as performance. Building relevant methods for documenting mixed music works should complement the technology-driven and the creative process-oriented documentation with performance knowledge relating to the sensory experience of a piece. Documenting immersive environments is yet another direction of

collaboration with various cultural heritage organizations.

Discussion

With these propositions in the background, I would like to come back to the organizational level of preservation. The principle of trust for digital repositories entails organizational infrastructure and sustainability for these organizations. In my previous paper, I emphasized the need to have trained professionals in digital preservation, similarly to LAMs, to manage repositories, which, of course, requires institutions and funding. Promoting FAIR and TRUST principles relies on relevant frameworks, in terms of repositories and in terms of workflows. But organizations involved in mixed music production and dissemination are not LAMs and while some LAMs have clear mission statements in relation to digital preservation, organizations and institutions involved, at some level, in mixed music do not, especially in relation to the long tail. It has sometimes been argued that digital preservation is more of an economic problem rather than a technical one, which may be a little bit too extreme a statement, especially in the context of complex artworks. Still, without dedicated funding, there will be no proper preservation for mixed music.

I would argue that the question of preservation of mixed music has to become a large-scale project – the idea of a consortium of some sort with various types of institutions – in order to reach for organizational sustainability as well as having enough impact to be able to propose and build upon existing software libraries, to define processing workflows (especially in relation to pre-ingest/ingest phases), and to define and enforce hard requirements.

I believe that without hard requirements the long tail is bound to disappear (it is difficult to quantify how much has already disappeared). If we have to accept a wide range of contributors – as opposed to most situations in LAMs – then we must be able to ask for best practices in terms of, as stated previously, file formats, complex objects aggregates, and metadata production. The subsequent aspect of the discussion on best practices relates more directly to preservation at the conceptual level and requires documentation protocols relating to sensory experience

and performance knowledge whose outputs may be evaluated at ingest.

Conclusion

Going back to FAIR and TRUST, we may think about the impact of our propositions. Findability, Accessibility, and Interoperability will be greatly improved by the coordination of efforts at the inter-organizational level. Reusability will be greatly improved by the subsequent ability to establish hard requirements and processing workflows, and participate in the building of software libraries.

The U of TRUST is User Focus, that is to say, "to ensure that the data management norms and expectations of target user communities are met" (Lin et al. 2020). It is not doing a U-turn to say that U is bidirectional. Specifying what is expected is also meeting the expectations of the target user community (a question that emerges regularly in discussion with practitioners in mixed music production), especially since we want to achieve Responsability "[...] for ensuring the authenticity [in the archival sense of the term] and integrity of data holdings and for the reliability and persistence of its service" (Lin et al. 2020).

Transparency, "about specific repository services and data holdings that are verifiable by publicly accessible evidence" (Lin et al. 2020), should be targeted, especially in relation to the long tail. And finally, Sustainability is our main goal, supported by relevant Technology and documented workflows.

References

Akkermann, Miriam (2017), "Composing an Instrument - Improvising a Composition: David Wessel Contacts Turbulents", in: Alain Bonardi et al. (eds.), *Analyser La Musique Mixte*. Pensée Musicale, Delatour: Sampzon.

Aufderheide, Patricia et al. (Eds.) (2019), "Code of Best Practices in Fair Use for Software Preservation" (2019), www.arl.org/ resources/code-of-best-practices-in-fair-use-for-software-preservation/, last access August 2020.

Barok, Dušan et al. (2019), "Archiving Complex Digital Artworks", *Journal of the Institute of Conservation* 42 (2): 94–113.

Boutard, Guillaume (2018), "La

Médiation et La Conservation Collaborative et Distribuée: Le Cas de La Technologie Numérique Dans La Performance Musicale", in: Anne Klein, Martine Cardin (eds.), *Consommer l'information: De La Gestion à La Médiation Documentaire*, Presses de l'Université Laval: Québec, QC, 57–75.

idem (2019), "Is There a Digital Archivist in the Room? The Preservation of Musique Mixte", in: *Proceedings of the International Computer Music Conference (ICMC)*, ICMA: New York.

Boutard, Guillaume and Catherine Guastavino (2012), "Archiving Electroacoustic and Mixed Music: Significant Knowledge Involved in the Creative Process of Works with Spatialisation", *Journal of Documentation* 68 (6): 749–71.

Di Cosmo, Roberto and Stefano Zacchiroli (2017), "Software Heritage: Why and How to Preserve Software Source Code", in: *Proceedings of IPRES 2017: 14th International Conference on Digital Preservation*, Kyoto, Japan.

Escobar Varela, Miguel and Nala H. Lee (2018), "Language Documenta-tion: A Reference Point for Theatre and Performance Archives?", *International Journal of Performance Arts and Digital Media* 14 (1): 17–33, https://doi.org/10.1080/14794713.2018.1453242.

Guastavino, Catherine and Brian F. G. Katz (2004), "Perceptual Evaluation of Multi-Dimensional Spatial Audio Reproduction", *The Journal of the Acoustical Society of America* 116 (2): 1105–15.

Lemouton, Serge (2012), "Vingt Ans de Pratique de La Réalisation En Informatique Musicale: Enjeux, Perspectives et État Des Lieux d'un Métier En Devenir", Master Thesis, Université Paris-Est.

Lin, Dawei et al. (2020), "The TRUST Principles for Digital Repositories", *Scientific Data* 7 (1): 144, https://doi.org/10.1038/s41597-020-0486-7.

Meyerson, Jessica et al. (2017), "The Software Preservation Network (SPN): A Com-munity Effort to Ensure Long Term Access to Digital Cultural Heritage", *D-Lib Magazine* 23 (5/6), https://doi.org/10.1045/may2017-meyerson.

Molenda, Ania (2020), "The Use of Preservation Tools among Dutch Heritage Organizations", Dutch digital heritage network, www.netwerkdigitaalerfgoed.nl/wp-content/uploads/

2020/06/NDE-The-Use-of-Preservation-Tools-among-Dutch-Heritage-Organizations-juni2020-2.pdf, last access August 2020.

Plessas, Peter and Guillaume Boutard (2015), "Transmission et Interprétation de l'instrument Électronique Composé", in: *Actes Des Journées d'Informatique Musicale* 2015, OICRM: Montreal, QC.

Tarlao, Cynthia, Daniel Steele and Catherine Guastavino (2019), "Investigating Factors Influencing Soundscape Evaluations Across Multiple Urban Spaces In Montreal", in: *Proceedings of International Noise*, Madrid 2019.

Wilkinson, Mark D. et al. (2016), "The FAIR Guiding Principles for Scientific Data Management and Stewardship", *Scientific Data* 3 (1): 1–9.

Authors of this issue:

Miriam Akkermann is musicologist, sound artist and musician. She holds a junior professorship for empirical musicology at Technische Universität Dresden.

Guillaume Boutard is an associate professor at Université de Montréal. His research interests include digital preservation/curation and creative process documentation.

Seth Cluett is a composer, artist, and writer. He is Assistant Director of the Computer Music Center and Sound Art Program at Columbia University and Artist-in-Residence at Nokia Bell Labs.

Kevin Dahan is professor of music sciences at De Montfort University, holding also diplomas in classical piano and jazz guitar, electroacoustic composition, and jazz arrangement.

Serge Lemouton works as a computer music designer at IRCAM, collaborates with researchers to develop computer tools and has taken part in the production and public performances of numerous musical projects.

Tae Hong Park is associate professor at NYU Steinhardt's Music Technology program, Music Audio Research Lab, and the Composition program and chief architect of Citygram – a comprehensive, real-time, scalable, and cost-effective sound-mapping project based on fixed and crowd sourced sensor network paradigms.

International Computer Music Association