

## Computer Music as Born-Digital Heritage

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### ABSTRACT

*The preservation of electroacoustic and computer music is highly problematic. This is also true for media art and for born-digital cultural heritage in general. This paper discusses the observations, conclusions and recommendations of a Dutch research project on the preservation of born-digital heritage in film, photography, architecture and art that are relevant for electroacoustic and computer music. References are made to research on the preservation of electroacoustic music. OAIS, the ISO standard reference model for digital repository, serves as a starting point. Discussed are the difference between born-digital vs. digitized heritage and the specific concerns regarding born-digital cultural heritage. Attention is paid to the lack of standardization. The recommendations include: to use a distributed OAIS model; to start soon and in an early stage, with simple, basic steps; the importance of education in preservation for art and music students and professionals. The preservation of electro-acoustic and computer music is linked to concerns relating to digital heritage in other cultural-artistic realms.*

### 1. INTRODUCTION

The “digital age” is imbued with the paradoxical problem of preservation and loss. Digital information is copied and kept easily in large quantities. Nevertheless, the preservation of digital information is enormously problematic, due to the vulnerability of storage media, the early obsolescence of hardware and software, the dependence on – and loss of – context and technological environment, complexity of copyrights, the large quantities of information and the lack of selection, ordering and metadata. This is considered a major problem for society and culture: the doom of a “digital dark age” [1, 2].

In electroacoustic music, this issue is very prominent [3–17]. The experimental, innovative, custom-made analogue or digital electronic technologies quickly become obsolete. A lack of standards is caused by technological and musical innovations and by intermingling with such disciplines as theatre or media art. Multiple creative agents are involved, resulting in a dispersion of knowledge and materials.

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### Comment by Marc Battier

“The preservation of electroacoustic and computer music is highly problematic” wrote Hannah Bosma in her 2016 presentation. Yet, this researcher fought a constant battle to help in the documentation and diffusion of electronic and computer music, while keeping a sharp eye on the contribution of women composers and gender issues.

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2014–2015, I investigated the issue of born-digital heritage in film, photography, architecture and (media) art in a research project for the Culturele Coalitie Digitale Duurzaamheid. From my background in electroacoustic and computer music, I will here discuss some of the observations, conclusions and recommendations of this research that are relevant for electroacoustic and computer music.

## 2. BORN-DIGITAL HERITAGE IN FILM, PHOTOGRAPHY, ARCHITECTURE AND ART

### 2.1 Background

The Netherlands is investing substantially in a national infrastructure or network for digital heritage [18]. The aim is to promote efficient and effective digital preservation and access for the digital collections of the large variety of archival organizations, libraries and museums in the Netherlands by linking collections, knowledge, and facilities. The work programme on the sustainable preservation of digital heritage is carried by the Nationale Coalitie Digitale Duurzaamheid (National Coalition for Digital Preservation, NCDD), a partnership of the National Library, National Archive, National Institute for Sound and Vision (Dutch broadcast archive), Data Archiving and Networked Services (DANS) and the CCDD. Since there is not a single large cultural organization that could represent the whole, diverse cultural field in the Netherlands, several cultural organizations form the Culturele Coalitie Digitale Duurzaamheid (Cultural Coalition for Digital Preservation, CCDD) to represent the cultural sector in the NCDD. The CCDD consists of organizations such as museums and knowledge institutes related to visual arts, cinema, photography, architecture and media art.

Remarkably, the performance arts (music, theatre, dance) are not represented in the CCDD and NCDD. Due to severe financial cuttings in the past years, in the Netherlands there are few specific archival organizations for the performing arts anymore. Because objects are a central concern in the visual arts, collections and archives are apparently considered of more importance for the visual arts than for the performing arts. In governmental prose

“cultural heritage” often refers to old buildings, old material objects and visual art only, excluding objects, documents, practices and works of the performing arts.

In the Netherlands, during the past decade there were several large mass digitization projects of national archives. Now that these digitization projects are more or less finished, it is acknowledged that the preservation of born-digital heritage, for which there is no original physical equivalent, poses a different and growing problem.

Various cultural organizations were trying to tackle this on their own. To promote the exchange of knowledge and experiences, the CCDD proposed a research project on generic workflows for the preservation of born-digital heritage in film, photography, architecture and art, the main domains of its members. Moreover, the need was felt to inventory and articulate the requirements of the cultural organizations for the developing national infrastructure for digital heritage. Otherwise, the danger lurked that the cultural organizations would not benefit from it.

### 2.2 The research project

This research project was called Generieke Workflows Born Digital Erfgoed. It was a 6-month research project of the CCDD, in cooperation with Stichting Digitaal Erfgoed Nederland (DEN), the institute for the preservation of media art LIMA and the Dutch national film institute EYE, financed by the Ministry of Education, Culture and Science (OCW) of the Netherlands. Researchers were Gaby Wijers (director of LIMA) and Hannah Bosma. The research consisted of literature study, in-depth open structured interviews with 34 experts representing 14 Dutch cultural organizations, museums, artists and producers related to film, photography, architecture and art, and an expert meeting (one day, ca. 50 participants). The outcome was a research report and a brochure with conclusions and recommendations, presented at expert meetings and available online for free [19, 20]. The results are incorporated in the work programme on the sustainable preservation of digital heritage of the NCDD.

## 3. DIGITAL REPOSITORY

A digital repository is an organization that provides storage, preservation and access of digital information, in a secure, reliable way, guaranteeing authenticity and accessibility. It consists of hardware- and software, processes and services, and the required people and means. A standard for digital repositories is the reference model for an Open Archival Information System OAIS, ISO 14721 (fig. 1, [21, 22]). This functional model describes all functions required for a reliable, trusted digital repository. We used the OAIS model as a reference structure for our analysis and for the generic workflow.

The OAIS model assumes that reliable, durable digital preservation consists not only of technically adequate data storage (bit preservation). The data have to be checked regularly. It is required to show that the data were not corrupted by maltreatment or decay (authenticity and fixity information); to transparently ensure the authenticity of the digital objects, the sources and the modifications of the digital objects must be registered (provenance information). Sufficient information on the digital objects is

required (metadata, representation information, context information). Access must be provided in usable, permitted formats to the permitted organizations or persons, under the required conditions (e.g., related to copyrights). Monitoring of the technological developments is required to notice whether the stored file formats still can be used (technology watch) and how to prevent their obsolescence (for example by transformation of the file format). Moreover, the repository itself must be maintained. The organization, including the financial means, must be stable, reliable and durable; in case of discontinuation, the organization must take action to safeguard the collection.

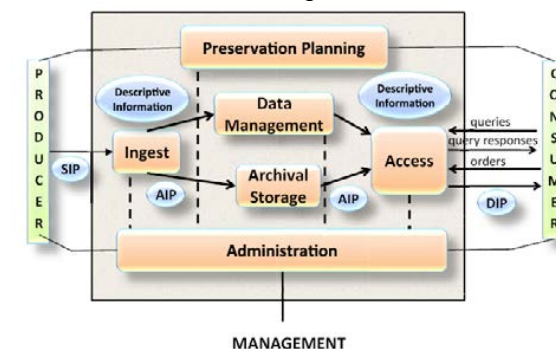


**Figure 1.** The OAIS model. *SIP* = submission information package; *AIP* = archival information package; *DIP* = dissemination information package.

Standardization of file formats is usually considered as vital for the efficiency and quality of the preservation of large numbers of digital objects in a digital repository. Digital repositories often have strict norms for format standardization or normalization of the ingested digital material.

## 4. DIGITIZED VS. BORN-DIGITAL

Compared to digitized cultural heritage, born-digital cultural heritage has some specific problems. The problems mentioned below are important for the domains film, photography, architecture and (media) art, but concern computer music as well.

There is **no physical original** or equivalent. This means that the preservation of the born-digital object in its original quality is of essential importance. If the born-digital object gets lost, the object (such as a born-digital art work) itself is lost. There is no physical object that could be digitized again. NB while initially, digitization was proposed as a strategy for preservation, now it is acknowledged that, in general, digital objects are far more vulnerable than physical objects. It is good practice to preserve the original physical objects after digitization. This is of course not possible with born-digital heritage.

Born-digital heritage has far more **variation in software formats** than digitized heritage. While a digitizing organization can choose a convenient, uniform standard format for its collection, born-digital objects have a variety of origins: by different makers in different time periods, in various contexts, with various functions, with and for various equipment, etc. This goes with a variety of soft-

ware formats and versions. This is even more the case with art and art music (e.g. [10] for electroacoustic music). Whereas mass consuming brings format standardization (to some extent), the digital objects made by artists and composers are often for specialists who present the work to the audience, for example by setting up an installation in an exhibition or by performing a composition in a concert. This goes with a larger variation of software, hardware and file formats. Moreover, cultural heritage institutions may be interested in the intermediate stages of the creative process of a composer, which adds even more variation.

**Large quantities** of files are typical for born-digital archives. Since digital storage gets increasingly less expensive and takes few physical space, it is easy for makers to keep many old versions, drafts, intermediate files, etc. For example in digital photography, the number of photographs taken and stored have increased enormously when compared to analogue photography. E-mail is another example, when compared to letters on paper. This is a challenge for institutions that collect artist's archives.

Born-digital objects get **easily lost**. Paradoxically, this goes hand in hand with the above.

- a) While it is easy to keep many digital files, it is as easy to throw them away. Some photographers thrash all the pictures of a session after having sent one to the newspaper. Many organizations thrash all e-mail from an employee who leaves the company, while, previously, paper correspondence was filed and stored; this could include correspondence with artists, for example. Thus, historical records and crucial information may disappear.
  - b) Storage media may become malfunctioning or damaged. Access may be compromised, because of the loss of passwords, lack of permissions, obsolete compression or encryption. Storage media may become obsolete, when they cannot be connected to or inserted into newer equipment (e.g., floppy disks, DATs, ZIP-drives, etc.) and the original equipment is not in use anymore.
  - c) Digital objects may become obsolete, because the old required software (version) is not available anymore and cannot be installed on newer equipment.
- b) and c) are common problems in music [13].

A **lack of ordering** is caused by 3) and 4) and by the lack of physical constraints. Different versions and various copies are made easily, kept in different places, storage media and formats. Later, it is often unclear what the authoritative, definitive or original version is of a born-digital object. This goes with a **lack of metadata** and a **lack of context information**. Although there are of course variations, in general physical archives or heritages are better organized than digital ones. Moreover, digitized collections were already selected, ordered and described as the original physical collection, before digitization.

The digital is **not an isolated** entity. Born-digital heritage is always embedded in a non-digital context. This includes such diverse aspects as hardware, cultural context, presentation, perception, institutional environments,

etc. This is especially the case with complex art works that consist of digital and non-digital elements, like installations or performance works. A one-sided attention to digital preservation alone, neglects the complete works and their contexts. The preservation of digital and non-digital elements has to be integrated.

These problems are present regarding born-digital heritage in general, but are especially prominent in the field of art, music and culture, where authenticity, originality, specificity, creativity and innovation are of essential importance.

## 5. BORN-DIGITAL CULTURAL HERITAGE

### 5.1 Standardization and obsolescence

For cultural-artistic born-digital heritage, standardization is often problematic, due to the importance of preserving the originals as much as possible. There is no way to force artists to use only specific standard file formats. Normalization to a standard file format often changes minor or major elements, while with regard to art, this is not allowed or not preferred without consent from the author. For museums, individual art works are of central importance, being of great artistic and often monetary value. In contrast with the use of standardization for the mass preservation by large archival institutions, tailor-made preservation and restoration are the norm for museum's art works, especially when it is for a specific, high-profile occasion such as an exhibition or performance. This also applies to born-digital art works.

The risk of early obsolescence is strongest in the first phases of new technologies, before consolidation, and in niche markets. Thus, experimental art/music and the remains of the creative production process are especially vulnerable.

When it is not possible to perform or install a composition or media art work due to obsolete software and equipment, tailor-made solutions are concerned with emulation, re-construction, repair, re-interpretation, revision or even making a new version, in collaboration with the author and/or other experts [3, 5, 6, 7, 15, 16]. "Authenticity" and "preservation" have different meanings with respect to archival science, art or music [16].

### 5.2 Domain-specific preservation

Because the technologies and practices of various cultural-artistic domains are so specific, we stress that several aspects of the OAIS model must be domain-specific.<sup>1</sup> This is the case with the *ingest*: domain-specific specialist knowledge is needed for deciding what kind of digital objects, formats, metadata and documentation are welcome or required in the digital repository. The *technology watch* also requires domain-specific specialized knowledge. And it also applies to *access*, related to the specific formats that are used in the domain, the kind of customers or clients, delivery times, delivery methods, copyrights, etc. (for example, while both belong to the audio-visual sector, there are substantial differences between the domains of film and of television with regard to

access requirements).

### 5.3 Beyond OAIS

Very important stages of the preservation process take place outside the OAIS model, at pre-ingest. Already in the production process, decisions and actions take place that are crucial for preservation, such as the choice of software, file formats, equipment and materials, and the documentation of the art work (requirements, technical specifications, intentions of the artist, production process, final result, etc.). Ideally, bit integrity check (by checksum or hash code) would start here and continue through all phases of the preservation workflow. Another important phase at pre-ingest consists of the policy, choices and requirements of cultural organizations regarding the born-digital material to be collected and the consultations and negotiations with makers, producers and suppliers about the selection, qualities, formats, documentation, copyrights etc. of the born-digital objects.

Moreover, subsequent installations, exhibitions, performances and interaction with the audience may be considered to belong to the artwork as well. The documentation of this may be crucial for later re-installation, re-performance, repair, reconstruction or (re)interpretation of the art work. Access is not only, and sometimes never, for "consumers", but often for professionals to exhibit or perform the work; this may feed back into (a revision or addition to) the born-digital object.

We developed a detailed workflow model for cultural organizations that takes these aspects into account: the pre-ingest is more than half of this scheme and there is a feedback line from post-access to pre-ingest.

## 6. RECOMMENDATIONS

The model of a large, central digital repository that has its own requirements regarding standard formats of digital objects and metadata, is not convenient for born-digital cultural-artistic heritage. Our recommendation is to use the OAIS model not as a scheme for a central digital repository organization, but as a kind of checklist to inventory where and how the various aspects of digital preservation will be organized: a **distributed OAIS model**.

The preservation of born-digital heritage is an on-going process with fast developing knowledge, insights and technologies, both domain-specific and domain-exceeding. Exchanging information and experiences within a specific domain, nationally and internationally, is very valuable; exchanging knowledge with other domains is important as well; this is best dealt with by bundling forces and sharing results in a network, and/or by delegating it to a domain-specific centre. Domain-specific digital preservation knowledge and practices can be developed and distributed via **domain-specific knowledge centres and/or networks**.

But still, there could be an important function for centralized preservation functions. Not with regard to the many domain specific aspects mentioned above, but with

regard to **bit preservation**. Bit preservation may seem a simple issue compared to all other preservation problems. However, it is still not a trivial issue at all. Notwithstanding the fast decreasing costs of digital storage, it has become clear that digital storage is expensive, because of the continuing and repetitive costs. Servers cost energy all the time. LTO tapes must be stored in safe, climate-controlled rooms. Digital storage must be checked regularly for bit integrity. Moreover, digital storage must be renewed regularly, because of the expected decay and obsolescence of the storage systems and media. Multiple back-ups must be synchronized. Etc. Cultural-artistic organizations could benefit from central, good, reliable, inexpensive, neutral bit preservation services, while deciding themselves about the file formats and metadata they want to preserve and make available, with the help of the domain-specific knowledge networks/centres that are sensitive to the balance between specific creative/artistic software solutions and the benefits of standardization. Moreover, many artists and other makers have problems with storing their digital work safely and durably (whether because of a lack of knowledge, money or attention). Offering reliable and inexpensive bit preservation to artists and small art/music organizations could be an important step in the preservation chain.

Preservation starts already in the initial composition or production processes of the digital objects. Thus, **education** in the preservation problematic is important as part of the curriculum of art schools and conservatories. Moreover, professional artists, composers and other makers of future born-digital cultural heritage need support and information regarding preservation as well. Such education for both students and professionals should be focused on: 1) raising awareness of the preservation problematic and 2) providing practical solutions.

Although a distributed OAIS model is a good reference, for small organizations and individuals the OAIS model may be too abstract, too ambitious and too unpractical. This may have a paralyzing effect, while it is very important to start with preservation soon. Therefore, some models are developed that provide **first steps for small organizations**, but that are scalable to a reliable digital repository. These start with raising awareness and with inventorying what is already being done regarding preservation. From this follows a next step to take and a next preservation level to aim for. The Levels of Digital Preservation of the USA National Digital Stewardship Alliance (NDSA) is a practical model that advises what a small organization or individual could do [23]. The Dutch *Scoremodel*,<sup>2</sup> developed by DEN and the Belgian digital heritage expertise centre PACKED, is a questionnaire to inventory the strengths and weaknesses of the current preservation practices of an organization and is more focused on organizational and administrative aspects than the NDSA model.

Given the limited resources of most cultural organizations, preservation measures must be as simple and effective as possible. There is a reflex to try to solve preservation problems by developing new software solutions. However, it is important to realize that new software sys-

<sup>1</sup> "Domain" refers to a specific (sub-)section of the cultural sector, such as media art, photography, film, architecture or electroacoustic music.

<sup>2</sup> <http://scoremodel.org/>

tems often bring new preservation problems. Instead, it might be a good strategy to go **back to basics**. Often, much can be gained by implementing simple, basic standards like adequate file naming, directory organization, sufficient documentation and trying to avoid dependency on proprietary or non-standard software.<sup>3</sup> Checking bit integrity throughout the preservation process requires the freely available MD5 hash checksum utility, organization and discipline. An example of an efficient, low-cost, high-quality domain-specific digital repository is the Dutch institute for media art LIMA, based on LINUX, LTO tapes, much domain-specific and domain-exceeding artistic and technical knowledge, an effective balance between Do It Yourself and collaboration, and a good network.

## 7. CONCLUSIONS FOR ELECTROACOUSTIC MUSIC

From the perspective of a distributed OAIS digital preservation model, much efforts in the preservation of electroacoustic music are concerned with pre-ingest, post-access and technology watch. We argue that such specialized tasks must be done by or with the help of specialized organizations or individuals and that, on the other hand, centralization could be helpful to provide reliable, low cost bit preservation.

Since decisions and activities in the production process determine later preservation problems to a large extent, preferably preservation must not take place after the fact, but early in the composition and production processes. Therefore, it is recommended to teach preservation awareness, skills and knowledge at art schools and conservatoria and at workshops for artists, composers, performers, sound engineers and other makers. Simple efforts in an early stage could make enormous differences for the preservation later in the future. As such, the author (composer, artist) is responsible for her/his work and its inherent preservation (see also [16]).

The visual arts are organized around the notion of the art object. Music, on the other hand, is concerned with performance. Laurenson pleas to use the notion of the score for the preservation and re-installation of media and installation art [24]. Roeder introduces the notion of performance in the context of digital record preservation [16]. On the other hand, the preservation of electroacoustic music could benefit from the rich theory and experience in the field of media art preservation. A cross fertilization of the preservation practices of media art and electroacoustic music could be fruitful for both domains.

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<sup>3</sup> In Dutch, the brochure *Bewaar als...* by Karin van der Heiden offers an overview of such basic preservation standards, see <http://bewaarals.nl/>.