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# Electroacoustic music studies and the danger of loss

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**Encompassing more than a century, music created through the use of diverse artificial audio technologies faces loss: of written documents, of musical scores, of instruments, machines and devices, of functional electronic components, of techniques and of a sense of the necessity which drove musicians to use a particular technology in a given context. In turn, the loss of documents leads to misunderstanding or oblivion. Today's electroacoustic music studies offer ways to remedy the danger of loss.**

## 1. LOSS OF MUSICAL INSTRUMENTS – LOSS OF KNOWLEDGE

In Rome's Instruments Museum, visitors are likely to miss a small display window hidden under a stairway. The small objects which one can see there represent the whole of the twentieth-century collection of this museum, two musical instruments symbolising the onset of the new instruments of the last century. Of course there are, in Europe, several museums in which twentieth-century musical instruments are well represented in comprehensive collections, such as the Musée de la Musique in Paris, the Gemeentemuseum in The Hague, Berlin's Instruments Museum or the Deutsches Museum in Munich. In these collections, one can see many electrical, electroacoustic and electronic instruments which demonstrate the revolution in instrument making. However, the two instruments found in Rome are far from this trend. They consist of a guitar and a strange percussion instrument. Both instruments belonged to Giacomo Balla, the Futurist painter who had musical training. The guitar was there for him to play, while he designed and decorated the unusual percussion instrument. It seems, thus, that the latter is a rare example of a Futurist instrument still in existence.

The Italian Futurists represent the spirit of the twentieth century in which various types of musical instruments were created. A large number of these instruments have vanished, among them the Futurists' noise machines. However, the first half of the century was rich in terms of the invention of musical instruments. It was also at that time that Maurice Martenot forged the expression 'lutherie électronique' (electronic musical instrument making), which must

not hide the fact that pure electrical means were also very fruitful.

In this article, I will raise issues linked to the study of electroacoustic music, some of which were discussed at the October 2003 meeting at the Pompidou Centre in Paris, organised by De Montfort University's MTI group and Sorbonne's MINT group under the auspices of IRCAM, which was the first such event in which international researchers met to discuss this topic.

These scattered reflections will be anchored in the underlying question of the repertory as a body of musical works, some of them quite famous and others not so well known or even quite obscure but nevertheless important. To study works from the repertoire of electroacoustic music, it may be essential to go beyond the obvious stylistic categories which may otherwise cripple our understanding of the whole evolution of this music and of its multiple forms. One solution is to consider the repertory to encompass all approaches of art music, as long as the works use some sort of technology in their composition, production or space projection. Often, this music emerges from the desire of musicians and sound artists to explore areas beyond what is commonly accepted. It is when this desire meets audio technology that electroacoustic music appears. When studying this music, it is necessary to consider the evolution of artistic ideas, stylistic trends, technological development and the techniques which appear from using new production means.

Electroacoustic music generally refers to a specific type of compositional approach in a well-defined historical period, starting after 1945. Other names for this technological music have been used, such as 'electronic music', 'tape music', 'live electronic music', 'computer music', 'acousmatic music', 'audio art', 'sound art', 'interactive music' and, in France, 'musique mixte', while some of these were later abandoned or had their meaning modified, such as 'plastic music', 'musique concrète' or 'experimental music'. The name electroacoustic music stuck and, although awkward and unsatisfactory, is convenient to designate a music born of electric, electroacoustic and electronic technology, used alone or in connection with instruments or the voice.

In my view, electroacoustic music studies should encompass all types of use of audio technology in the creation of art music. Furthermore, the path which led to latter-day sound techniques can be traced back to the end of the nineteenth century, when the idea of artificially produced sound was a subject of importance among certain artists, many of them writers. I will draw several examples from a time when electroacoustic music as we know it today did not exist, but when musicians and artists became attracted to new audio technology and appropriate techniques were developed.

I have suggested in a previous issue of *Organised Sound* that the history of technological music can conveniently be segmented into five categories.<sup>1</sup> I will not comment on this categorisation any further and will use it as a foundation to mention various types of technological usage in music, some of them quite old. When dealing with such a long history which spans over a century, it becomes striking that many experiments, even many musical works, have been lost or cannot be performed in their original form. The idea that loss accompanies evolution is obvious. When applied to art, loss is too often equivalent to oblivion.

## 2. LOSS IN PHONOGRAPHY

Probably the most significant invention of the late nineteenth century in the domain of sound is the mechanical recording, which appeared simultaneously in 1877 in France (Charles Cros) and in the United States (Thomas Alva Edison). However, it took many years before the phonograph became a tool for musical creation. And when it did, it was in the form of a fantasy, of a dream.

It is interesting to note that writers have been the first among artists to predict new forms of sound production, as early as Rabelais and his frozen speech or Francis Bacon and the sound houses of *New Atlantis* (1624–1626), Jules Verne's (*Le Château des Carpathes*, 1892), Edward Bellamy (*Looking Backward*, 1897), Guillaume Apollinaire (*Le Roi-lune*, ca 1908, published in 1916), and many others. A striking example of this trend in which writers take their inspiration from machines can be found in a novel by Villiers de l'Isle Adam, *L'Ève future* (1886), in which an artificial woman is able to speak through a machine imagined by a character which the author dared to name Thomas Alva Edison!

Visual artists such as Mondrian and Moholy-Nagy were tempted by experimenting with phonography. It may be because of the fact that sound is engraved into a groove, thus making a sculptural gesture. In 1923, Moholy-Nagy dreamed of engraving new sound material directly into the groove, a gesture that the

French writer Raymond Roussel had envisioned in his novel *Locus Solus* (1913), in which he gave the phonograph a magical role. In the novel, Lucius, who became mad after his daughter was murdered, recreates her voice by patiently engraving the groove. In this case, Roussel envisioned sound synthesis before anyone else.

The history of phonography is accompanied by losses. Russian Futurist Tziga Vertov's Ear Laboratory, for instance, was based on a project to manipulate phonograph recordings in the years 1916 and 1917. It led the artist to disappointment as the mechanical recording device was very cumbersome and probably also because its audio quality left a lot to be desired. Still it produced experiments which are of historical importance and, to this date, have not been recovered.

Around 1930, work by Paul Hindemith as well as ventures by Darius Milhaud with variable-speed turntables and sound distortion exploited the still untapped creative possibilities of the phonograph. Although these experiments have yet to be unearthed, they showed a path towards the transformation of the phonograph into an instrument suitable for artistic creation.

## 3. LOSS IN ELECTRIC AND ELECTRONIC MUSICAL INSTRUMENTS

Electronic musical instruments started to appear during the first half of the twentieth century (thereminvox, 1920; ondes Martenot, 1928). Soon composers were drawn to these new possibilities. One of the first composers to express a strong interest in electrical sound devices was Ferruccio Busoni as an answer to his quest for new temperaments:

I received from America direct and authentic intelligence which solved the problem in a simple manner. I refer to an invention by Dr. Thaddeus Cahill. He has constructed a comprehensive apparatus which makes it possible to transform an electric current into a fixed and mathematical exact number of vibrations, and the apparatus may be 'set' on any number of vibrations, the infinite gradation of the octave may be accomplished by merely moving a lever corresponding to the pointer of a quadrant. (Busoni 1913: 95)

Residing in Berlin, Busoni was not able to experiment with Cahill's Teilharmonium, and never was to hear its sounds. One who did, though, was Busoni's pupil, Edgar Varèse, who declared about Busoni's interest in Cahill's device:

He was very much interested in the electrical instruments we began to hear about and I remember particularly one he had read of in an American magazine, called the Dynamophone, invented by Dr. Thaddeus Cahill, which I later saw demonstrated in New York and was disappointed. (Varèse in L. Varèse 1972: 50)

<sup>1</sup>Battier (2003).

Varèse's comment goes to show that the technology of his time (probably 1915 in this case) was not necessarily what he expected, and he had to specify what his needs were. In 1936, Varèse described a musical machine he was dreaming of as a sort of special instrument directly connected to the composer's control. As he put it in 1936:

Personally, for my conceptions, I need an entirely new medium of expression: a sound-producing machine (not a sound-reproducing one). Today it is possible to build such a machine with only a certain amount of added research. (Varèse 1936)

He wanted to conceive an electronic device which would be driven by a mechanically encoded score. It would have been necessary to devise a symbolic notation system adapted to the electrical production of sounds. If the Varèsian instrument had existed, its notation would have been difficult to decipher as it would have been a set of symbols aimed at controlling its mechanism. It would be like a control programming language rather than a general-purpose language, and a wiring schematic and proper documentation of its operation would have been necessary. In electroacoustic music studies, such technical sources, too often overlooked, are among the most important documents to preserve.

One of the first composers to have created a new instrument was Henry Cowell who, with the help of Leon Theremin, invented a device he called the Rhythmicon in 1931.<sup>2</sup> Of the two instruments built in the United States, only one remains and is preserved at the Smithsonian Museum of American History in Washington DC. The pieces Cowell composed, *Rhythmicana* (later renamed *Concerto for Rhythmicon and Orchestra*), and *Music for Violin and Rhythmicon*, could only be performed using the Rhythmicon. It seems that the first public performance of *Rhythmicana* was permitted by a computer simulation of the device achieved by Leland Smith at Stanford, and took place in 1971, several years after Cowell's death. While the Rhythmicon was a rare device, other electronic musical instruments were tentatively mass produced, among which the RCA theremin (1929), which has been used in several movie sound-tracks and in concert music, and the Trautonium, used by Hindemith amongst others, unfortunately very rarely these days.

Reynold Weidenaar, an American researcher who wrote a remarkable study on Thaddeus Cahill, spent several years looking for traces of the giant Telharmoniums built around the turn of the twentieth century. Because of the huge amount of copper used in the instrument, he searched the New Jersey scrap metal sites, to no avail. It is as if the devices had

vanished. Fortunately, he was able to use the patents which describe the sound synthesis principles and methods, as well as numerous newspaper clips, letters, photographs and reports. Although nothing, however, will ever replace an actual audio recording of it, thanks to the documentation patiently amassed, the author was able to reconstitute significant facts of the life of this unique instrument. It is also thanks to the work of another researcher, Canadian Gayle Young, that the pioneer work of Hugh Le Caine is now well known and documented. Other examples include the documentation on Martenot's Ondes, Theremin's life and instruments, and the work of Raymond Scott.

The recent interest in the preservation of these pioneers' works has certainly been fostered by the increase in communication which the Internet has rendered possible. Web sites, discussion lists and email correspondence are responsible for creating a sense of awareness that simply did not exist before. Important endeavours in the field of documentation and study of electroacoustic music are solely Web-based. One must mention here the EARS project,<sup>3</sup> Electronic Music Foundation's Institute, OLATS (Observatoire Leonardo des Arts et Technosciences) programme of electronic arts pioneers, and MINT – Sorbonne's ongoing projects of compiling tables of contents of all major periodicals in the field and of Web-based multimedia musical analyses. Internet communication has served as a way to sensitise a growing community of musicians and researchers to the problems involved in electroacoustic music studies and in their solutions.

#### 4. LOSS OF STUDIO MUSIC

Even after the arrival of a tape recorder in their studio in Paris, Pierre Schaeffer and Pierre Henry continued to use the electrical phonograph recording system with which the early *musique concrète* studies had been realised. Soon after, though, these works were transferred to tape, a medium supposed to ensure faithful reproduction.

However, the problems linked to the storage media of tape music are well known: the degradation of the tape medium has been studied.<sup>4</sup> While it varies according to brands, tape thickness, storage conditions and even, in a given brand, to different types, it is inexorable. Solutions, fortunately, exist although the life span of new digital media is a subject of speculation.

There is another aspect of early tape music which may be lost: its performance systems. First, non-standard recording devices were sometimes used, such as the Sony multitrack recorder Stockhausen used in 1966 for the realisation of *Telemusik* at the NHK

<sup>3</sup>See Simon Atkinson/Leigh Landy's article in this issue, [www.mti.dmu.ac.uk/ears](http://www.mti.dmu.ac.uk/ears)

<sup>4</sup>See also Daniel Teruggi's article in this issue.

<sup>2</sup>See Schedel (2002).

studio in Tokyo. No longer able to play back the tape, the machine is now useless and the original master tape cannot be heard. The same problem happened before, in fact, with Stockhausen's *Gesang der Jünglinge*, performed in Cologne in 1956 with a five-channel set-up, or with Olivier Messiaen's *concrète* study, *Timbre durées*, performed in 1952 from a triple tape recorder, a device assembled from three single-track tape recorders and which used a unique spatial projection system called 'kinetic relief' or *relief cinématique*, not to mention the 425 loudspeakers used to reproduce the stereo tape composed by Edgar Varèse for the Philips Pavilion in 1958.

Quite early in the history of laboratory electroacoustic music, space became a part of the compositional process, which raises many problems when it comes to performing such a piece while preserving the diffusion characteristics. As Stockhausen put it,

From which side, by how many loudspeakers at a time, whether with rotation to left or right, whether motionless or moving – how the sounds or sound groups are projected into space: all this is decisive for a comprehension of the work. (Stockhausen 1961: 68)

## 5. UNDERSTANDING TECHNOLOGY: RESOURCES, POSSIBILITIES, BOUNDARIES

Understanding how technology has been used in a piece means the analyst must study the techniques developed by the composer. With the advent of computer techniques, it became easier to realise electroacoustic music from notated musical scores. This corresponds to the classic scheme of the Western composition procedure, which is based on a common musical notation system. There is, however, an important difference, which is the fact that, more often than not, the composer's gestures are inscribed into the heart of the sonic material. Rather than having an instrumentalist give a personal view and change the way a piece of music sounds through performance, the gesture of the composer drives the making of the way the piece will be realised. Gesture, in this case, is an ensemble of techniques mastered by a composer. It is through these techniques that a relationship is made between a score, or a musical intention, and the making of a piece. Elsewhere I have compared these gestures to the *faktura* of Russian Constructivists: they are present throughout the composition and realisation of an electroacoustic piece (Battier 2003).

There are certain reasons why a composer chooses to use a device or a program in a certain way. These have to do with the composer's own style. It becomes necessary to raise the analysis approach to the level of the writing of the piece or, as the French word implies – *écriture* – to envision the intention, the notation and the style of the composer at the time it was realised. Composers share similar production means,

such as software or processing devices, but the personal creative dimension drives them to use these resources as no one else. The hypothesis behind this assertion is that there exists a specific *écriture* adapted to the electronic production environment, which, while the technology itself is universal and shared by many, is uniquely inscribed in the work. The analyst's task consists of extracting it and turning it into a symbolic object, that is, into a text.

This is an ambitious task. It will be aided, though, by an increasing number of textual documents which accompany the production of music. To this end, a thorough understanding of the technology used can be obtained through study of various types of texts, such as common musical notation scores, computer scores for acoustic compilers such as, for example, MUSIC V, CMUSIC CSOUND, real-time processing software patches and programs (MAX/MSP, Super Collider, etc.), studio reports and paratexts such as concert programme notes and articles aimed at non-specialised audiences.

Because some synthesis packages have such a close relationship to their programming environment, computer language manuals are also useful. In the case of Jean-Claude Risset's pieces and tutorial sets published in 1969, a particular problem arises. As Risset put it in the introduction to his tutorial catalogue,

The catalogue [...] is intended as an example to be followed by people working in sound synthesis, so that others can benefit from their findings and so an extended repertory of sounds can be made available for tone quality studies and for computer music (Risset 1969)

However, to benefit from this early – and splendid – effort, the reader has to overcome several difficulties. The first one is that it has become difficult to run MUSIC V programs, because other acoustic compilers prevail, such as CSOUND or CMUSIC. This is why language manuals, such as Max Mathews's 1969 book are useful to understand the syntax and vocabulary used in MUSIC V. However, Risset's catalogue's examples use another layer of computation in the form of conversion subroutines (CONVRT), PLF (subroutines used in MUSIC V's pass 1) and PLS (for MUSIC V's pass 2). These programs are written in Fortran, a computer language which first appeared in the mid 1950s, which, although still in use, has been largely superseded by C and object-oriented languages. In order to understand and implement the examples, knowledge of MUSIC V and Fortran is necessary.

Since the appearance of MUSIC 11 in 1973, synthesis packages are real programming languages, a feature inherited from the structure of MUSIC IV (1963). A CSOUND (1984) score, for instance, may be composed of the traditional orchestral instruments and note lists, but more often than not will be written as a dense set of instructions in a C-like language.



Table 1

Computer	Type used at the first performance (to provide an example), speed, RAM memory size
Peripherals	Size of hard disks, other necessary peripherals
Audio acquisition and conversion	Number of channels, sampling rate
MIDI	Number of channels
Diffusion	Number of loudspeakers. Number of channels. Types of loudspeakers (stage, sub-bass, etc.). Set up in the performance hall.
Microphones	Number; types (contact, aerial, HF) and models used in the first performance
Effects	Compressors, limiters, equalisers, reverberation, harmonisers, etc. Precise description of models and versions for future reference.
Controllers	MIDI keyboard. Other MIDI controllers (faders). Pedals (switch or volume). Joysticks. Non-standard items (gloves, bodysuits).
Software	Name. Version used in the first performance. Platform and operating system under which the software runs. See Software environment in table 2.
Sampler	RAM memory size. Sample map. Voice settings (filter, pan, volume, envelope, etc.).

Knowledge of the programming language is a necessity if one wants to grasp fully the intention and role of these instructions. This is how the analyst can understand how a composer adapted a general-purpose language to the specific needs of the work.

A recent study of Jonathan Harvey's 1980 tape piece, *Mortuos plango, vivos voco*, has shown how valuable composer sketches are. The original MUSIC V texts – orchestras and scores – could not be retrieved. To study this pure tape piece, the analyst had access to Harvey's private documents and could discuss them with the composer. Thus, many compositional techniques of the piece were uncovered and thoroughly explained.

Because electroacoustic music has been in existence for a rather long time and has generated a whole living repertoire, part of which is available on commercial recordings, it is indeed possible to assemble a variety of material in order to study and analyse an electroacoustic piece or a body of work. It is not difficult to accept the idea that such a long history of compositional practice has generated a volume of documents in addition to the music itself. Loosely drawing from archivist categorisation, I will subdivide them into 'texts', 'paratexts' and 'documents'.

Texts are composed of a wide diversity of written and graphic primary material, such as patches, analogue synthesizers' dope sheets, program listings, computer instruments, note lists, and so on. Paratexts are heterogeneous elements which help in the reception of a work, such as titles, epigraphs and dedications, and commentaries of a work such as programme notes. Documents consist in secondary sources not necessarily related to music: handbooks and manuals of various technological tools such as computer programs and audio devices, as well as texts

related to art history, sociology, aesthetics, philosophy, semiotics, cognitive sciences, etc.

Table 1 lists the information for typical live electronic pieces using real-time digital systems, such as those produced in the early 1980s. It is presented as an example of a guideline for the preservation of information data used for performance and should prove useful in electroacoustic music studies. It can also be used for tape music and pieces for tape and instruments or voice. Table 2 is a blueprint to help in a comprehensive documentation of pieces using computers in their performance. It is derived from a template devised by the author during his tenure at IRCAM in the 1990s.

There are large institutions which store and manage documents and records for this music. Libraries such as the Bibliothèque Nationale de France or the Library of Congress have comprehensive music departments. Their collections consist of musical scores, books, personal archives and music periodicals. Specialised libraries maintain whole collections of scientific and technical periodicals and books; this is the case for large university libraries and research institutions. Many European radio organisations and associated audiovisual media institutions tend to do archival work by storing large sets of audio and video recordings, and many of them are engaged in research for date retrieval from massive collections of document records. Institutions which are or have been doing music research and production, such as INA-GRM and IRCAM in France, or Milan's RAI are taking important steps towards preservation and access to their collection of published and unpublished material. Also, music information centres, such as CDMC in France or the ones found in Europe, Japan, North America and elsewhere, are good places to find

Table 2

General presentation	This is where the reader should become acquainted with the specifics and the intention of a piece, as well as its mode of presentation and performance. A more comprehensive study could also be included.
Audio connections set-up	Place of all necessary microphones; audio signal paths to processing devices (reverberation, equalisation, compression, spatialisation, other processing); A/D and D/A conversion; routing of output of audio signals; mixing; connection to loudspeakers.
MIDI connections set-up	Must display channel numbers. Should show list of MIDI devices, control channels and patching.
Audio and MIDI set-up from the first performance	Referring to the first performance's set-up is invaluable. While technology will evolve and be replaced in the future, a snapshot of the first performance can explain a lot.
Digital processing map	When digital processing is used (such as with a computer programme – MAX/MSP, Super Collider, jMax, etc.), a map of the data flow, a list of processing functions and I/O modules as well as a careful notation of settings is most useful for study (as well as for a technical port to latter day technology).
Diffusion set-up	Live pieces tend to use more than two channels. A map of the diffusion set-up for spatialisation should clarify the choices made by the composer and those taken by the technician for a particular performance.
List of all prepared soundfiles and sound samples	Direct-to-disk and sampler technology tend to evolve rapidly. It is most important to know the sampler's map, its program settings and the triggering systems. Screen shots can be useful. When triggered from a MIDI device (keyboard or gestural controller), precise MIDI messages (usually voice messages) should be noted. It may be that the performer's score has these indications already.
Software environment	In addition to the information given in table 1, this is where a comprehensive indication of the overall software environment is given (list of necessary plug-ins, abstractions, patches, programs, settings).
Signal processing scheme	Data flow representation of the signal processing algorithms.
Preparation, tests and rehearsal	Steps to be followed to install the set-up and conduct tests. Indication of rehearsal procedure.
Performance	Steps to be followed and overall procedure for the performance of the piece.
Programme notes	The programme note is a paratext. As such, it is important to use the programme notes from the first performance, although other versions might have been produced later.

documentation on living composers and music from musicians working in their own country, such as scores, paratexts, associated documents and audio recordings. Finally, museums not only acquire, store and preserve musical instruments, but often give researchers access to their own document records archives.

When it comes to classifying methods, one encounters several approaches. Museums, for instance, have their own agenda of preserving, restoring and sometimes finding ways to keep instruments in a playable state, and accompanying repository documents are used as technical guidelines for these aims.<sup>5</sup> Major libraries, on the other hand, especially national ones, are more focused on archival methods.

<sup>5</sup>On the steps taken by a museum regarding electronic musical instruments, see Sylvie Ramel's article in this issue.

One cannot expect electroacoustic music centres to conduct thorough data management. Most of them simply do not have the time, the resources, the methodology. Their interest lies elsewhere, mostly in the production of new music and in its public performance. It is a complex task to gather the documentation necessary to electroacoustic music studies.

An important missing tool is a thesaurus. A multilingual thesaurus would be a useful instrument for understanding terms whose meanings are sometimes uncertain or have changed over time. For instance, the word 'sample' has taken a whole new significance these days. At the onset of computer music, the term 'sample' is what digitalisation and sampling theory defines as a single number representing an instantaneous amplitude in a waveform. With the arrival of real-time recording devices in 1980, the word was used

to designate a whole sound which could be played back on a digital sampler instrument (Davies 1996).<sup>6</sup>

## 6. CONCLUSION

To help electroacoustic music's repertory to live, to be better known and performed more often, efforts should be made to understand it better. Understanding technological works means studying the way they should be performed, how they ought to be presented to the public and, also, the technical context in which they were born, their possibilities, limits and resources.

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<sup>6</sup>Developing such a thesaurus forms part of the EARS project at De Monfort University.