

THE IRCAM DIGITAL SOUND ARCHIVE IN CONTEXT

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Domestic and institutional archiving and dissemination of texts, images and sound (as well as 3D representations, haptic sequences and so on) have been deeply affected by the advent of digitisation, which has opened up vistas unforeseeable a few decades ago, mainly due to its potential of quasi-infinite perfect reproduction (sometimes called 'hyper-reproducibility'). Digitisation has indeed induced a profound breach in the technology of memory from the way in which it had emerged in the industrial age, in particular regarding music.

At the turn of the nineteenth century, the development of analogue reproduction – in particular the phonograph – allowed for the establishment and development of a powerful record industry which made possible widespread access to music of all kinds (including music directly derived from this technology, such as jazz, or reinvented by the record industry, such as baroque music). The separation between artistic production and cultural consumption has had very positive effects: a large public – at least in the industrialised world – has acquired a vast (if shallow in places) knowledge of music history and its cultural diversity.

However, in turn, reproducibility has also caused a huge regression in the musical audition capacity of this public: the

record buyer-consumer does not need to know anything about music in order to listen to it, nor share with the music producer-composer any instrumental or formal, practical or theoretical knowledge. He cannot read or play music any more; his ears have no eyes and hands, as it were. He is nescient.

Digitisation has brought about a major change in the fundamentals of the whole process, and therefore constitutes a vast opportunity for change, in particular with respect to music, and even more so learned music, and this concerns us directly at IRCAM¹⁶ (<http://www.ircam.fr>).

IRCAM IN THE DIGITAL AGE

This thesis, put forth by Glenn Gould as early as 1966, has led us to redefine at IRCAM the policy of production, use and broadcast of digitised documents, and in particular of sound documents. It doubtlessly affects the process of music creation; the issue of digitisation is therefore not just a question of patrimonial archival and collection production or of access modes, but a reinvention of the whole field of *lutherie* (or instrument-making).

IRCAM is thus in transition from the age of computer music to that of music creation in the era of generalised digitisation, which will affect, among other things, home HiFi systems, media for offline dis-

'As limited as it is, the manipulation of dials and buttons is an act of interpretation. Forty years ago, a listener could only turn his turntable on or off, and maybe, if it was an advanced model, adjust the volume somewhat. The variety of controls available nowadays requires a capacity for analytical judgment. Yet these controls are still very primitive in comparison with the means of participation that will be offered to the listener when the current very sophisticated techniques still in the labs are integrated into domestic appliances'.¹⁵

tribution as well as online access, and, in due course, the modes of listening, both professional and amateur. We are therefore working on tools for computer-assisted music composition as instruments of description, indexation and representation of musical sounds, including means of genetic traceability of the works, among other things. We are also developing instruments for musicological analysis, as well as an authoring environment for producing personalised formalised and transmissible 'signed listenings' of a musical piece (by a musicologist, teacher, conductor or musician), to be used as listening guides or a graphical track on a musical DVD to be used in the HiFi appliances of tomorrow. In addition, we are putting together a Web radio channel, which will allow access to these analyses as well as to music as it is being created or the *avant-première* production.

It is within this new context that the IRCAM multimedia library has evolved into a laboratory and become part of a wider project about new *lutherie*, at the heart of which is the digital document.

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¹⁵ Glenn Gould, 'Idées' (1966) in Bruno Monsaingeon *Le dernier puritain* (Fayard, 1983), p. 88. Translated from the French by the authors of this paper.

¹⁶ *Institut de recherche et de coordination acoustique/musique*, founded in 1976, is a not-for-profit organisation and an associate department of the Centre Pompidou (the French national centre for arts and culture).



Figure 1. IRCAM Audio Player

THE EMERGENCE OF THE MULTIMEDIA LIBRARY AT IRCAM AND ITS DIGITAL COLLECTIONS

From its inception, IRCAM has been engaged in scientific research into, and technological development for, all the phases of music creation and production, from the elaboration and exploration of ideas by the composer, through its actualisation in a paper and/or electronic score, its live performance on stage by instrumentalists and computers, and its off-stage life-cycle. The R&D department is working in close collaboration on research and artistic projects with composers trained in its Pedagogical department, with instrumentalists and with other artists. The public performance of their resulting compositions is then handled by the Production department.

This abundance of projects and activities generates a wealth of intellectual production, in the guise of music scores and recordings of performances on the one hand, and scientific publications and conferences on the other. In 1995, the Multimedia Library was established to organise and integrate into the existing research library as many as possible of the archives of this production, thereby ensuring both preservation and access in con-

text. In 2002, the Hypermedia Studio was put in place, with the goal of exploring novel means of, and tools for, 'active' listening to digitally recorded music, for musicological research, teaching and individual appropriation. In conjunction, the External Relations department has been actively seeking partners,

via European projects and other means, to share, develop and valorise know-how, infrastructure and content.

THE MULTIMEDIA LIBRARY SYSTEM

The basic building blocks of the system, uninterruptedly operational, scalable, and evolutionary since 1996, consist mostly of off-the-shelf hardware¹⁷ and software¹⁸ components. As the modular design allows for replacement without interruption of service, the system has regularly been subject to upgrades reflecting the evolution of standards, software and hardware, converging towards an increasingly generic integrated solution for archival access and valorisation of cultural content.

From the very first version of the system, user access has been provided by means of Web technology,¹⁹ which allows in-house and external access (search, navigation and retrieval), in French and English, to a variety of multimedia content. All databases can be queried through forms, and each item (data, metadata) has its own URL. Domain-specific search strategies are provided. For example, the documentary database allows for searches by genre and subgenre, period, instrumentation, and so on. The library catalogue can be browsed according to the classification

scheme, and 'walked through' via a 3D virtual representation. Digital documents can be searched by type, availability and other musically pertinent criteria. However, while all the metadata is available from anywhere on the Internet, each item of data is access controlled, depending on the particular rights associated with it.

From within the library, special interfaces have been designed to provide convenient and secure²⁰ access. The Web browser, based on Internet Explorer, has been adapted to remove all unnecessary and unsafe controls,²¹ while the multimedia player, providing a familiar metaphor of a (physical) CD even for archives which never existed in this form (see Figure 1), shows the structure of the musical works (title, movements), information about the performers, as well as the booklet (for CDs) or the programme notes (for IRCAM concert archives).²²

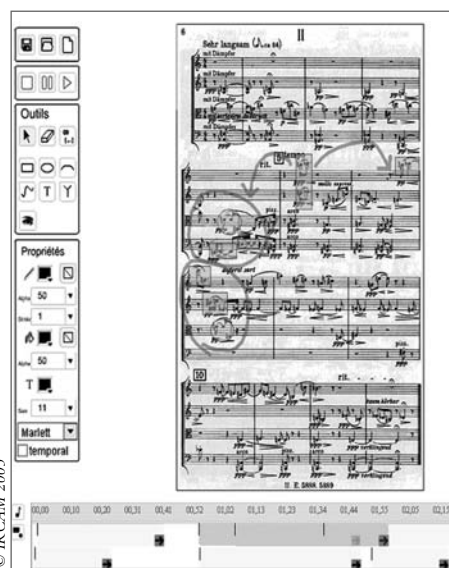


Figure 2. Score annotation tool. The scanned score is annotated with the help of a graphical palette (on the left) specifically designed for musical usage. The annotations can be placed and moved along the time axis (lower part of the figure).

17 Servers and local clients: PC. Underlying network and protocol: Ethernet (100 Mb/s and 1Gb/s), TCP/IP. Good quality audio boards (Digigram) and headphones (Senheiser).

18 Web server: Apache, with PHP-MySQL extensions; Loris (library software system); 4D (composers database).

19 Accessible at <http://mediatheque.ircam.fr/>, subject to restrictions due to copyrights.

20 Securing the content was a precondition to be allowed by the rights holders and their representatives to provide this access.

21 The only available controls are 'back', 'forward', 'refresh' and 'stop'. It also takes over all of the screen and does not allow for escaping to other programs or to the system. This allows for securing both the platform and the content in this public space.

22 This player also works as a VCR when viewing movies.

FROM PRESERVATION TO ACCESS

All IRCAM performances (concerts, conferences) have been recorded since the late 1970s by the Production department, first on analogue, then on digital tapes for archival purposes. After the Multimedia Library system became operational and an adequate agreement was signed with the appropriate music rights societies, the following steps were added to provide for both digital preservation and access to these hitherto sealed archives:

1. Transfer to a mixed-mode CD²³:
each tape is transferred (by means of digitisation in the case of old tapes) to one or several audio tracks of a writable CD; the description of the event in a structured form is written in a computer-readable file in the first (data) track of the CD.
2. For each tape, two identical CDs are produced. One is archived, the other is transferred to the Multimedia Library.
3. The audio contents of the latter CD are extracted, compressed and transferred to the online area. The description contents are imported into the appropriate database.
4. The online metadata is then verified, validated and cross-linked with appropriate online resources.

As a result of this process, every document that is archived is made available online. We are currently developing various automation strategies for the last two steps above so as to facilitate retrospective online transfer of archives.

FROM ACCESS TO INDIVIDUAL APPROPRIATION

While books in a library are – at least – contextualised by their neighbours on the shelf, the issue of ‘nearness’ acquires a different meaning in the digital space; objects can have many neighbours with whom they can be put in context, either manually, automatically or both.

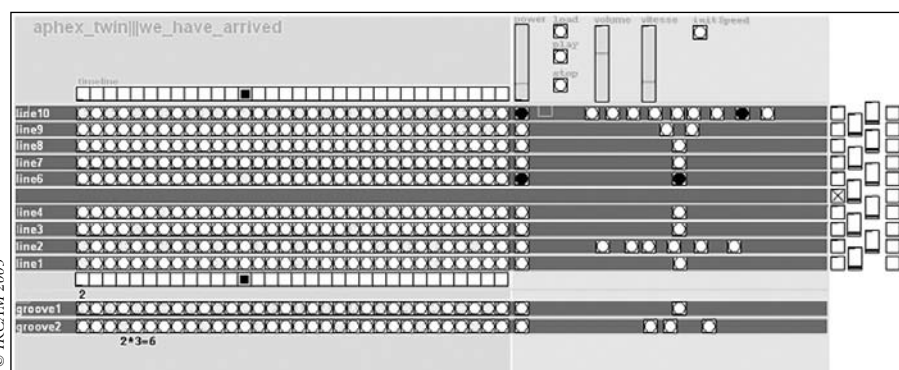


Figure 3. Signed Listening of an electronic music loop by Andrea Cera. The loop is manually decomposed into several audio layers, representing (as in sequencers) along the time (horizontal) axis the impacts. Some of the lines can be masked (here, the 5th one), so as to allow one to focus on other parts of the loop. Some operations such as slowing down can be used to refine the listening and synchronize it with the transcription. A condensed view of a phrase is inferred (in the right half) from the initial transcription. The simultaneous representation of several layers (bottom lines) allows one to search for and characterize implicit regularities in the transcription.

During the first stages of the project, this has been achieved by providing cross-links between related objects through their related metadata; the library record for a score provides links to the online biography of the composer and a documentary note about the piece, which in turn can link to all available online recorded versions, both from the IRCAM audio archives and commercial CDs.

The increased availability of off-the-shelf multimedia authoring tools has, therefore, allowed for the creation of higher-level integrated objects, such as musicological analyses (text, audio, diagrams), interactive score-and-performance presentations, Websites and so on – all based on the existence of the underlying sound archive and the ready availability of its material.

The question of the digital availability of these cultural contents within a technological context can be re-addressed nowadays in order to integrate usability in better and novel ways. Providing access to collections means not only making them available through structured and adaptive digitisation, but also allowing the user to

appropriate those elements s/he is interested in, through an individual, singular and unpredictable process.

The IRCAM Hypermedia Studio aims to provide tools for these purposes, based on technological experiments directed by users: musicologists, composers, music lovers. In particular, the project of Signed Listeners, launched in 2003, strives to propose instruments for personal listening purposes. Specialists of different types of musical listening are asked to imagine, using commercially available or IRCAM-designed technology, a representation of their individual way of perceiving a given piece or corpus. With the help of an engineer and a musicologist, each one authors a hypermedia mock-up²⁴ with the following characteristics:

- it exemplifies both a way to listen to, and a way to analyse, music;
- it allows the end listener to reproduce and/or alter the author's manipulations of the musical material (synchronisation, annotation, semi-automatic analysis of the signal, of the musical structures etc.), thereby becoming an author in his or her own right.

²³ A compact disc which comprises audio and data tracks.

²⁴ These are not necessarily functional objects, but models of what a finalised tool should look like after adequate development, allowing experts to test their ideas visually and aurally in a collaborative way.

These experiments (using various technical set-ups including Web plug-ins, DVD and installations) will allow us to determine both the generic and specific components of such a system, the former laying the ground for a possible access tool for all types of (musical) collections, the latter for specific corpora. For example, annotating a scanned score synchronised with a recording is generic to any corpus of music pieces that have both a score and a digitised recording (Figure 4 shows such a mock-up done at IRCAM for the MUSICWEB²⁵ European project). On the other hand, manual transcription of an electronic or repetitive music loop, with or without filtering the spectrum so as to reveal hierarchical rhythmic patterns, is specific.

TOWARD A NEW CONCEPT OF MULTIMEDIA TEMPORAL OBJECTS

Providing simultaneous access to content and to tools as a systematic process in this project is a necessity, in particular as IRCAM is a place for artistic creation and production of complex temporal objects. This is especially true of works belonging to the family of the new music of the second half of the twentieth century which mixes score and software, for which the modes of listening are rarely if ever codified and the analysis tools underdeveloped. As well as the general issues of access (e.g. indexation, navigation) to temporal objects there also arise questions of more or less local, more or less singular characteristics (modes of annotation, musical structures and so on) specific to learned Western music. This is why IRCAM is working on a new concept of a Web Radio (see Figure 4) closely related²⁶ to the Signed Listening project. The main stream (structured like a traditional radio programme, hence the name) provides pertinent access to digitised content. The 'auditor' will thus be able to explore the



Figure 4. Mock-up of Web Radio (example of a program about Edgard Varèse's *Déserts*. The main stream alternates interviews and musical excerpts (represented by the two colors). It allows the listener to access the full source documents used by the producer (here, an excerpt of *Le Sacre du Printemps* provides access to the full recording, represented by a longer horizontal bar below). The listener-spectator can thus navigate between a main stream and stored streams. In addition, he can appropriate himself any stream by annotating it; here, four lines of annotations mark excerpts from the program for different reasons (favorites, important citations, thematic indexation...).

content by accessing proposed ways of listening (by means of Signed Listeners provided by specialists) and by appropriating the content, and thus formalising his or her own listening on top of, or in parallel with, the one proposed by the editor.

NEW LISTENING TOOLS FOR AUDIO AND MUSICAL ARCHIVES

Music, and particularly contemporary music, raises acute and essential questions about the temporal object in the digital era – its exploration, annotation and restitution in all of its synthetic complexity, by individual users with singular modes of approach. The coordinated musicological, scientific and technological research programmes at IRCAM aim first at addressing them specifically, and then produce normalised and generic access tools for the listener, for whom the archive is a multiple-entry object, which can be interpreted in different, even contradictory, ways.

To allow for these entry modes by means of open and usable listening tools, IRCAM is about to coordinate the Semantic HiFi project.²⁷ The goal of this project is the development of a new gener-



A view of the Multimedia Library, as seen in its virtual 3D interface (<http://mediatheque.ircam.fr/infos/vrml/index-e.html>)

ation of HiFi systems offering novel ways of searching content, interacting with the musical material, and visualising and personalising the musical data.

The cultural and educational challenge specific to IRCAM-created music is vital: analysing it allows users to explore issues of listening and composition that are common to almost all kinds of music. It allows for the comprehension of most of the musical objects as complex temporal entities. The listening tools which will be developed in this context will thus open up new ways of accessing learned music, as well as learned access to 'simpler' music.

BACK TO PAGE 1

²⁴ These are not necessarily functional objects, but models of what a finalised tool should look like after adequate development, allowing experts to test their ideas visually and aurally in a collaborative way.

²⁵ New communication and information technologies in the music classroom, coordinated by the AEC (Association Européenne des Conservatoires, Académies de Musique et Musikhochschulen).

²⁶ Publication in the Web radio is done through a scenarisation file, which is an XML description (some existing standards are tested for this representation) of the sequencing of the various media and excerpts. The Signed Listeners can be seen then as either associated media or main stream.

²⁷ In collaboration with Sony, the Fraunhofer Institute, Native Instruments, the Universitat Pompeu Fabra (Barcelona, Spain) and Ben Gurion University (Israel).