Dowloading Musical Signs

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INTRODUCTION

In 1977, the Voyager interplanetary probes 1 and 2 were launched into space. Their mission was to send back to the Earth information about the outer planetary system and the limits of the solar system. Although their transmissions were not meant to last more than a few decades, the Voyagers also carry a more long lasting idea: to project our communication with the future. Both spacecrafts include a phonograph golden record containing natural sounds from the Earth and pieces of music produced by different cultures and eras. In the recorded information, one can find the first movement of Bach's Brandenburg Concerto No. 2 in F, Azerbaijani bagpipes, Senegalese percussion, and the Latin phrase *Ad astra per aspera* (To the stars through difficulties) in Morse code. The hope that, in a distant future, this little piece of human culture may be discovered by an alien civilization reminds us of lost seamen sending messages in bottles thrown into the sea.

The idea of projecting culture in time has always been present in the development of the human kind, oscillating between the recuperation and maintenance of past values and knowledge and the quest for something that would bring us a step closer to the future. These two poles have been present in the history of music; either as a celebration of certain compositional procedures or in the revolutions that ended up destroying them. Eventually, a certain period or segment of our culture experiences a state of stability in which the music does not look for the past or the future, but only its presentness.

The end of the 20th century, in which we observe a real explosion in the production of cultural signs, seems to be one of these times and the world-wide computer network, known as the Internet, one of its most significant emblems. When the Internet eliminates several time and space limitations, it enables experiencing the presentness. The information exposed in the Internet is the most precise reflection of the *now*: it is an information in constant mutation. Internet sites proliferate in quantity and diversity and, like a live and complex organism, transform themselves driven by chance and necessity. In opposition to institutions like the University, the Museum, and the Library, the Internet does not try to preserve, but simply to show what it is interesting in the present moment. Neither past, nor future: the time in the Internet is "up to date".

As any other field of human knowledge, music also proliferates in the Internet. Initially, due to technical reasons, it was not possible to send music through the digital network, but it was possible to talk about it. Powerful data search engines are able to

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use simple keywords to locate theory, critique, history, chronicle, technique, bibliography, biographies, and discussions related to different aspects of music in a matter of seconds.

The importance of the utilization of the Internet in music research and education is still to be evaluated. In addition to the traditional discussion forums, today, one can find sites devoted to other forms of processing knowledge. Universities and all sorts of institutions maintain web pages with information about composers, their works and biography; research centers and laboratories make the results of their most recent work available immediately. Some even undertake experiments on psychoacoustics and musical cognition with Internet users across the world. Electronic journals and magazines, which would have a very limited number of readers if they were available in printed format only, start to proliferate, bringing sound file libraries and collections of music scores. People interested in very specific subjects such as microtonality and fractal music are now able to "get together" in e-mail discussion lists. Musicologists, composers, and instrumentalist can divulge their latest works and share their doubts, interests, and apprehension with their colleagues.

But, the challenge of bringing music to the Internet still persists. Only very recently, promising solutions are being proposed. A number of factors contribute to this situation. In general, they refer to the large gap between the capacity of the Internet to transmit data and the enormous amount of data required to represent musical sounds.

In fact, the dissemination of music on the Internet suffers from two major problems. First, although the Internet was designed to carry any kind of data that can be represented digitally, the low bandwidth of existing Internet equipment make it almost impossible to transmit all the data generated by musical applications. A CD-quality sound file containing a single piece of music may require several hours to be transmitted through a conventional phone line. High-speed networks that lower the transmission time to some minutes or seconds are only available in large commercial organizations and research institutions. Secondly, music depends upon an extremely subtle temporal control which is even more difficult to obtain in current systems. The Internet protocols developed during the 70s and 80s (and which are still used nowadays) were designed for text and file transfer and not for streaming multimedia data such as music. Thus, they are optimized for operations like FTP and are not able to handle real-time data properly.

The worst case is that of real-time live transmissions like, for example, a concert in which the musicians are located in different places. It is not possible to guarantee a temporal regularity with a delay within a range that would be considered acceptable for this kind of performance. However, we foresee that these limitations will be resolved in the beginning of the next decade with the development of new communication protocols, high-speed networks based on optic fibers and new technologies, and the development of new hardware and software tools for manipulating multimedia data.

LOOKING AT THE PAST

The idea of transmitting music across long distances is much older than the recent computer networks. The first experiments with long distance music transmission occurred at the same time the first experiences with phonographers and telephones took place, in the last quarter of the 19th century. These two inventions were intimately related in their origin. Thomas Edison thought the phonographer as an extension of the telephone that would allow recording and repeating messages. In spite of using different technologies (the telephone was an electric equipment while the phonographer was totally mechanic) both machines, which incurred on fundamental changes on the way of life during the 20th century, appeared side by side in Edison's research in the decades of 1870 and 1880:

> However, Edison was at the time more interested in the idea of a telephone relay than in a sound-record machine, and he appears to have put the development of a purely mechanical recording system aside in favor of an electro-mechanical telephone-relay development (Ford, 1962: 222).

Although the use of the phonograph in conjunction with the telephone, as imagined by Edison, did not happen immediately, their combined use was explored musically. As Michael Chanan states:

> In 1880 a concert in Zurich was sent over telephone lines to Basel, fifty miles away; the following year an opera in Berlin and a string quartet in Manchester were transmitted to neighboring cities, and in 1884 a London company offered, for an annual charge of £10, four pairs of headsets through which subscribers would be connected to theatres, concerts, lectures and church services (Chanan, 1995: 26).

The invention of the Telharmonium, or Dynamophone, pointed to a series of changes that would take place in the way music is appreciated in the 20th century. Created by Thaddeus Cahill in 1897, it was one of the most audacious and creative technological realizations of the beginning of this century. Cahill's machine was composed of a collection of modified dynamos which employed inductors to produce alternating currents of different audio frequencies. It was controlled by a sensitive keyboard similar to the ones used in modern synthesizers. The instrument, however, did not generate the sound directly. Instead, it transmitted electric signals through phone lines to remote locations. According to Cahill, the Telharmonium could actually handle thousands of phone lines simultaneously. A paper cone was attached to the telephone receiver in order to amplify the sound. In March 1906, the magazine "Electrical World" commented, in its editorial, a demonstration of the instrument in Holyoke, Massachusetts as "the birth of a new electrical art". An article in the same issue of this magazine speculated about the new possibilities the instrument brought:

> The question will naturally arise in the mind of the reader as to the practical use of this complicated and expensive apparatus. The plans of the inventor are to distribute music from a central station to hotels, restaurants, theatres and private homes. The remarkable purity and strength of the sounds produced electrically, enabling a few performers at a central station to produce orchestral music at a thousand places, strikes the imagination and it seems not improbable that at no distant day orchestral music for dinner table will be as common in the homes of the people as it is now in the great hotels (Electrical World, 1906: 521).

In the same year, in July, another article in "McClure's Magazine" reports how the Cahill's instrument would represent an impact in the music scene:

> Dr. Cahill's new invention suggests, if it does not promise, a complete change in the system by which a comparatively few reach people enjoy the best music to the exclusion of all others. Instead of bringing the people to the music the new method sends the music to the people (Baker, 1906: 291).

In this article, the author refers to the democratizing power of the Telharmonium as it could be used to bring music even to small villages and remote farms. This idea, that later became true with the widespread use of the radio, was not what motivated Cahill to start its extremely ambitious project (the Telharmonium weighted around 200 tons and its cost was close to US$ 200,000). Cahill's initial idea was the same one that motivates most of the projects for creating new instruments nowadays, i.e., to give "the player *absolute control of the tones produced*" (Baker, 1906: 298). The

Telharmonium should allow the musician to control, in a precise and comfortable manner, all parameters involved in the production of sound, from timbre to articulation. Unfortunately, Cahill's project turned out to be impracticable with the technological and social possibilities of his time. Nevertheless, it is remarkable that questions such as control of non-mechanic instruments, long distance sound transmission, and democratization of the musical space have re-emerge, almost one century later, in the minds of people involved in musical technologies. If Cahill's instrument had survived throughout this period, by now, we would probably have better answers to many of these questions.

Still during the first half of the 20th century, radio brought new energy to musical culture. With no doubt, the collaboration between radio stations and the phonographic industry enabled an unprecedented expansion in the dissemination of different kinds of music. Radio and records made the presence of the listener during a musical performance no longer required. This eliminated the spatial and temporal barriers that permeated musical appreciation. Since then, music assumed an omnipresent condition in our society and the frontiers between the production of each culture were diluted in the dense web of mass culture.

In the 60s, Ted Nelson, a visionary to whom the creation of the term *hypertext* is often credited, imagined a world-wide network that would work as a large library in which the whole human production would be stored; interconnected computers would eliminate spatial and temporal barriers of communication. This utopical project, called *Xanadu*, would allow any type of information to be made available and commercialized through inter-computer connections. *Xanadu* survived for three decades as an emblem of a great step towards the future in human communication. But, despite all the efforts and charisma of its creator, Ted Nelson, the project was never completed and became, as said in the computer industry, *vaporware* (for information on this visionary project, see Wolf, 1995). It was only after the development of the World Wide Web (WWW), in the early 90s, that the possibility of making large amounts of text, audio, and image easily available became concrete. It experienced an extremely rapid growth and, today, it is difficult to think of a segment of our culture that it is not represented in the millions of pages that compose the web.

MUSIC ON THE WEB

The use of the WWW in music production and diffusion faces two fundamental problems concerning the nature of music language. The first one is related to representation. Usually, the discussion on this subject, either among researchers or in the specialized media, is limited to acknowledge that available systems for digital sound encoding generate files that are too big to be delivered through the Internet. Behind this matter is the question of representation of what we understand as music nowadays. Representational systems such as music notation and sound recording played an essential role in the evolution of Western music language. The development of those systems were crucial for the formation of new ways of doing and understanding music just because they provided forms of representation of some specific aspects of music language and emphasized the importance of different parameters of musical discourse. When the Internet became a significant medium in our culture it was necessary to establish new forms to represent sound and music. These new forms of representation will certainly modify our understanding of music as well as social and cultural relations which are linked to our musical practice. Music history is rich in examples when similar situations ended up changing the configuration of musical life. It happened with the development of notation in the end of the Middle Age, with the establishment of music printing during the Renaissance, with the invention of the phonograph by Thomas Edison in 1887, and again with the explosion of the phonograph industry and radio broadcasting during the first half of the 20th century.

The second problem is related to time, since music is essentially a temporal language. Each culture and each period has created appropriate tools and procedures to deal with temporal issues in music. These tools and procedures have been determined by different cultural and social contexts, such as the technological development of musical instruments, the social and physical space were music took place, the technique reached by virtuosi players, and the compositional accomplishments of each epoch. For example, during the Middle Ages the cathedral's resonant acoustic where Gregorian chant was sung has contributed towards the constitution of a temporal articulation of long and well defined notes which was necessary to assure that the sung words would be clearly understood. This situation is completely different during the Classical period when an acoustic environment more favorable to the definition of each sound, the ability of very skilled luthiers, and the consolidation of a sophisticated system of notation allowed for a much more precise and refined temporal manipulation of sounds.

During the last decade, the Internet has become a new space for the realization of music and, for this reason, one can expect the development of new tools and procedures devoted to the manipulation of music data in time (Kon & Iazzetta, 1998). It will lead to significant changes in the behavior of music language itself.

Different alternatives have been tested and, today, there are a few possible ways of transmitting music through the Internet. One of them is the transmission of MIDI files. In computational terms, MIDI files are very economic since very little information has to be coded. Current systems allow the transmission of MIDI files through a regular telephone line between computers located at different parts of the globe. Although it may be satisfactory for some situations, MIDI files are designed to contain information related to notes and durations, they do not contain a representation of the sound itself. That is, delivering a MIDI file is something like sending a music score to be played by an electronic device at the other side of the connection. For this reason, musical results -- specially in terms of timber and articulation -- are totally dependent on the characteristics of that device. In the last 15 years, the MIDI protocol became one of the most stable standards in the music industry, leading to failure any attempt to improve its characteristics and limitations. Projects such as *Extended MIDI* (Wilkinson, 1995) and the *ZIPI Protocol* (McMillen, Wessel, & Wright, 1994) did not succeed in facing the hegemony of the MIDI standard. However these protocols presented a great improvement on current MIDI systems. The ZIPI Protocol, for instance, formalizes a flexible framework which deals with different music parameters such as pitch and dynamics, as well as localization in a three-dimension space, and control of timber, articulation, brightness, attack, and spectral components of sound.

Audio data compression is another area of active research. It can be achieved by customized software and hardware that compacts audio data before delivering it. Before it can be played at the destination machine, the information must be uncompressed. However, in this context, compression usually leads to loss in quality: the higher the compression rate the larger the quantity of information that is lost during the process. In spite of that, recent audio compression algorithms support the real time transmission of audio streams with fairly good quality. The MPEG Layer 3 standard, for example, uses psychoacoustic models to filter the most relevant information for the human hearing and to eliminate what we cannot perceive. Through banks of filters, entropic compression, quantization, and handling the redundancy between the two channel of stereo sound, the MPEG protocol can compress audio files up to ten times and maintain a near-CD quality.

Recently, some effort has been put on the search of alternative models which would allow for more economic ways of sound representation. *NetSound* (Casey & Smaragdis, 1996) is a system for audio and music transmission which is able to deliver, over the Internet, audio information that is fed into the *CSound* environment, producing music in real-time. The most evident advantage offered by NetSound is that the system does not transmit digital audio signals but only the mathematical description of the sounds that must be reproduced at the target machine.

The success of these ideas still rely on the improvement of current network systems, specially in what concerns the quality and capacity of home connections (e.g. the ones based on telephone lines). However some efficient ways for the production and transmission of musical material are already available at the Internet. Radio broadcasting are now a common place on the WWW and there is a significant growth in the number of concerts and other types of events transmitted in real time over the Internet. Tools and protocols for compression and delivery of audio data such as MPEG3, RealAudio, and Shockwave made the possibility of incorporating music in web sites a reality. Also, one can expect that commercial exploration of these resources will represent a meaningful stimulus for the use of music on the Internet.

One of the current experiences regarding Internet music is the Brain Opera project, coordinated by Tod Machover from the MIT. Brain Opera is an open work under continuous growth. Part of the project is set towards the realization of performances and installations in which sound production is controlled by the gesture of players and spectators. These installations include environments such as *Gesture Walls*, which transform gesture in sound and image by capturing electrical signals from the subjects bodies, and the *Rhythm Tree*, an sculpture containing 300 pads acting as electronic drums spread through the branches of an artificial tree. Simultaneously, a WWW site invites remote users to interact with the musical material for the Opera either by sending their own sounds or by interacting during real-time performances.

Some composers are using the MAX environment (Puckette & Zicarelli, 1990) to produce and distribute their compositions over the Internet. In 1996, the composer Otto Henry created *Oedipus Max*. This piece in three movements can be downloaded from the Internet or saved in a floppy disk to be performed on a Macintosh computer connected to a MIDI instrument. The music is conducted by chaotic processes and contains rhythmic and diatonic passages. In addition to the music, twelve images are shown on the computer screen during the performance. This concept of musical work brings some novelties in relation to traditional models of composition. First, composition, programming, and instrument design are blended in one activity headed by the composer. Secondly, the listener assumes the conduction of the performance on his or her own computer. Finally, what the listener receives is neither a score nor a recording of the piece, but a program containing the processes which will generate the piece.

Another pioneer work was developed by Karlheinz Essl. The composer has created a collection of objects for the MAX environment called *Real Time Composition Library*. Using this system he has been creating interactive compositions that can be distributed over the Internet. Among these works are the *Lexikon-Sonate* and *Amazing Maze*. The latter is an interactive algorithmic composition that can be manipulated in real time. What is remarkable is that the program which generates *Amazing Maze* also contains the sounds used in the piece. These sounds have been digitally recorded by the composer himself from real instruments. The realization of the piece can be automatic or controlled by the user. Works of this kind are pointing out to new ways of music production and distribution which are directly related to the expansion of the Internet.

CONCLUSION

The expansion of the digital network represented by Internet and its different protocols is not limited to the growth in the quantity of information available to users worldwide. The Internet also introduces meaningful changes in our cultural life: it changes the way we organize our relations in space and time and the manner we produce signs. One cannot underestimate its importance or limit its scope to technical aspects. The Internet is a powerful medium which reorganizes the way we interact with the signs that surround us. By establishing its essential role in the core of our culture, the Internet acts as a new pole of sign production. Every language or system of signification which approaches this pole will experience a semiotic expansion. The French scholar Pierre Lévy points to this question:

> "Today we experience a redistribution of the configuration of knowledge which became stable with the generalization of printing during the 17th century. When intellectual technologies create and destroy the cognitive ecologies they contribute to deviate the foundations which command our apprehension of reality [...] The passage from speech to writing to computing as fundamental modes of the social management of the knowledge does not happen by substitution, but by complexification and shifts of gravitational centers" (Lévy, 1993: 10).

At the same time that the institution of a cyberspace tends to shift the gravitational centers where music language has its foundations, the Internet stimulates and emphasizes the immediate character of our music realizations. While our musical life is guided towards the preservation of tradition and the creation of a ubiquitous language, the Internet stimulates the exposition of instantaneous ideas and personal views. The net is the medium for the presentness: it grows and evolves as a living organism which is constantly adapting itself to current conditions. Thus, the semiosis acquires a virtual character: instead of accumulating sings of the past and connecting them to different territories, cultures, and lands, the time of the Internet is now and its locus is here. Its mode of operation is not devoted to the preservation, but to the dissemination of signs.

The music carried at the Voyager interplanetary probes was projected towards an uncertain future, it was an attempt to attach a character of eternality to our culture and musical past. On the contrary, the music of the Internet represents the affirmation of our present. And the more the present becomes evident the better we see how it is ephemeral.

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