Computer Music in Chile: The Beginning and some Paths to Nowadays
An historical review

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Abstract

In the early 70's a small group of people started the computer music activity in Chile. Among these group of professionals and students, there is a remarkable figure: José Vicente Asuar, composer and engineer, pioneer of electroacoustic music in Latin America. This beginning is well documented, although its position within the corresponding historical framework has not an adequate correlation and there is no a proper theoretical connection with the related works in the next decades, either at Chile and the region or within a global context as well.

This paper intends to give a brief review, and as comprehensive as possible, of the historical events involved within this starting point of computer music in Chile. Among these events there are the first explorations in computer-assisted composition by means of algorithmic procedures, the use of a computer to control analog synthesizers and theoretical texts on these explorations. This little history, small because has few protagonists and occurs in few years, has a leading character in the figure of Asuar, whose relevant technical work, music and thinking is examined in order to trace paths and prospect links in the future generations. Virtually all the mentioned activities were generated by Asuar, whom carried out diffusion through the release of two LP's. Important is the vanguardistic interdisciplinary work that leads to these works of engineering and art, activity accomplished within the Universidad de Chile.

Nevertheless, there is one more achievement by Asuar, maybe the most significant: the creation of an original computer for only one purpose, that is the creation and performing of music. This computer, the COMDASUAR (Asuar Digital-Analogic Musical Computer) created in the late 70's, had several interesting features as being unique at its moment and combine digital and analogic technology in one equipment. This article shows the general structure of this machine, its synthesis engine and its tools for assisted composition as well, highlighting the combination of a quartz digital oscillator and filtering analogic devices, capability for programming western tempered music, microtonal music or other types, serial techniques and aleatoric procedures named by the author as 'heuristic'.

At the same time, this text addresses significant milestones of the history of informatics in Chile, specially focusing from 1961 to the 80's, period that is the conceptual and technical soil where computer music establishes their foundations. This period marks the arrive of the first digital computer to Chile in 1961 and the social and political evolution of the country through the use of

computers within the socialist project of Salvador Allende at early 70's and the neoliberal economic system implanted by the military dictatorship from 1973 onwards. The use of informatics in different areas such economics, scientific research or in one hand the violation of human rights and in the other hand the protection of these rights, are the constitutive elements that gives the conceptual framework for the artistic works with computers in Chile.

So, this amalgam will cause, at first, a specificity that confine this knowledge in specialized centers within the academic, state and industrial scopes. The lack of others researchers in this confluence area between art and technology, will cause a gap very notorious if we compare the development on this field in a country like Chile and the main centers of technological and industrial progress located in Europe and North America. After the entry of the first digital machines at the 60's, the consolidation until the 80's, passing through the socialist experience of the network project by Stafford Beer during the Salvador Allende's government in the early 70's, it will come the expansion of computing during the growth of the neoliberal economic system by the middle of the 80's decade. Through this evolution, the achievements by Asuar were forgotten and only viewed with attention abroad within the international electroacoustic community. Moreover, based in Barcelona, the prominent Chilean electroacoustic composer Gabriel Brnčić put his own algorithm in a collaborative work which reached an state of consolidation with his software 'Ronde-Bosse' for assisted composition at the early 2000's. Besides this experience, only with the arising of the personal computer alongside the new impulse and the opening of electroacoustic music to new generations due to this technological massification phenomena, a group of researchers, artists and composers will trace a genealogical path between the contemporary Chilean computer music and the pioneering realizations by Asuar and connections with Brnčić's artistic, technical and pedagogic work.

Finally this paper covers the essential ideas within the 'Ronde-Bosse' and the theoretical corpus on the use of technology in music by Brnčić. At the same time, this article completes the panorama of computer music in Chile making a review of the actual state of the art with a short list of Chilean composers that use computers in music, either for acousmatic, mixed or instrumental creations.

1. First computers in Chile: the 60's

The first digital computer arrived to Chile in 1961. Before that, analogic computing had a history linked to the IBM company evolution in Latin America starting with the settlement of the Computing Tabulating Recording Company (IMB's predecessor) offices in 1914 in Argentina, Brazil, Uruguay and Chile in 1929 with only two employees whose were in charge to assist the National Institute of Statistics (Medina & Miller, 2005: 51-52). The Chilean government already had started to import tabulating machines by IMB since 1921 and the private sector imported calculators, typewriters and tabulating machines by the American brand as well. By the second half of the 1950 decade, IMB dominated the Chilean market and provided machines for military institutions, state companies and various private sector clients (Medina, 2013: 103-104)

Within this context, the main use of these technologies was focused on data administration and in the beginning of the 1960's Chile had the staff and the necessary knowledge to improve their

systems, grow up in quality, expand the field and to be ready for the arrival of the digital computers.

In 1954 the Engineers Institute of Chile published the "Chilean Telecommunications Policy". According to Álvarez and Gutiérrez:

> This report motivated the establishment in 1960 of the National Telecommunications Commission and the creation of the National Telecommunication Company […] in 1964 as a branch of the Chilean Agency for Technological and Industrial Development. (CORFO, Corporación de Fomento de la Producción, created in 1939) […] State and industrial needs also strongly boosted demand for professional information processing. (Álvarez & Gutiérrez, 2012: 23)

With the arrival of the IMB 1401 in 1961, the first digital computer in Chile, purchased for the Valparaíso Customs Agency, the Chilean government had implemented a constant policy of development in the area, which first stage is the consolidation of computing as a tool for different state's areas, such as Treasury, Railways, Navy, Air Force, Army and Internal Revenues, institutions where digital computers were allocated the next two years.

As Álvarez and Gutiérrez state (2012: 24), the main uses of these machines were administrative tasks, management of data and automation of statistics and inventory, planning applications.

On this time of initial growth, the digital computing is adopted by the private sector as well, meanwhile the academia started to install machines since 1962 with the Universidad de Chile acquisition of a German Standard Elektrik Lorenz computer ER-56 for the School of Engineering. The mood implicated in these years is well defined by Álvarez and Gutiérrez:

> Next, Catholic University (1963), the Technical University Federico Santa María (1964) and the University of Concepción (1965) acquired IMB 1620 computers. The main purpose of these first academic computers was to support the necessary calculations to solve problems in other disciplines, such as numerical calculation, differential equations, statistics, linear programming, structural analysis, and network analysis. […] The first computer installations in universities required the organization of computer centers that mainly functioned to manage the use and operation of the machines and to provide programming services to various university and external users. A power struggle developed among mathematicians and electrical engineers regarding where these centers should be located. Some other voices claimed that such centers were unnecessary. However, the high-level activity made possible by the first center at the University of Chile proved that it was justified. The center facilitated graduation projects and research on structural analysis, system simulation, and operations research, and it provided services to ministries, government agencies, and CORFO (roads, electricity, irrigation, and so on). (Álvarez & Gutiérrez, 2012: 24-25)

Thereby it seems like in the academic context had exist a strong sense of collaboration that grew up within an ethos of synergy. As in every human endeavor, the motivations for this behavior are diverse, but assuming the possible personal interests or misgivings, the literature suggested an environment marked by the necessity to establish and cultivate a healthy common ground. The spirit was to develop the area in itself and to get the proper field to investigate, create and to profit. It is important to state here, that the administrative and scientific branches of development will converge by the 60's second half, having a productive interaction of consolidation in general terms, guiding to an increasing expansion through the 70's and beyond the 80's.

Regardless the drastic political changes in the nation, including severe and violent transformations, computing keeps the pace and never decreases in research, endeavor and growth.

The main changes are given in the sphere of the uses, but at the same time in the implied ethos of these uses, whom lead to a notion of society and nation.

Until this moment the computing was a area in development that needed technicians, engineers and programmers whom were provided by the universities through a cluster of careers and courses.

2. Cybersyn

One of the relevant endeavors was the visionary project initiated by the socialist government of Salvador Allende, whose political alliance, the Unidad Popular (UP), won the elections and operated between 1971 and 1973 when was overthrown by a *coup d'état*.

With an idealistic vision of socialism, shortly after had taken office in November 4th 1971, Allende meets with Stafford Beer, the prominent British theorist and cybernetics expert, whose knowledge on management cybernetics was on record due to his abundant writings and practice.

Contacted by Fernando Flores, Technical Director of CORFO during the Allende's administration, Beer joined a multidisciplinary work team whose aim was to create "a national communications system, a new cybernetics – based control system to be applied to the entire social economy of Chile." (Bechler, 2002: 3)

As a independent consultant, Beer applied his proficiency and expertise to design the vanguardist project 'Cybersyn' (Cybernetic Synergy) or in Spanish 'SYNCO' (Sistema de Información y Control), a communication and administration system based on computers and telex to shape a network to control de economy and the state-run sector industries and agencies, allowing the maximum of production and low management along with a ideal independency of workers (Medina, 2013: 147-148).

The mainframe IMB 360 was the core of the system, receiving the data from the teletypes. The software implemented was the original Cyberstride. The design of a Operations Room according to the principles of the GESTALT, was the input by a group leaded by Gui Bonsiepe, a designer whom bring the background of the Hochschule für Gestaltung at Ulm, which itself was heir to the Bauhaus (Medina, 2013: 183-192).

Never ended due their interruption by the *Coup d'état* in September 11th 1973, the project leaves certain traces.

Its focus on the integrated work, a global vision of the systems and non-hierarchical approach to the human organization. This ethos would contrast with the neoliberal approach to computing in the next decades. This antagonism and forthcoming intermediate visions will define the future attempts and achievements.

The next years after September 1973, were marked by the implementation of one of the most ruthless and violent dictatorships of the 20th century, a military government that abolished the parliament and started the enforcement of the neoliberal experiment, an economics plan following guidelines established by the Chicago School of Economics. The derogated government supporters and the political opposition was hardly attacked and repressed. The

dictatorship of Augusto Pinochet implemented a methodic system of murder, torture and prosecution by means of two agencies, the Direction of National Intelligence (DINA) replaced after by the National Information Centre (CNI), which used informatics to perform their state's terrorist activities:

> A less standard area of application that merits mention is the 'hidden information battle' within the human rights realm. Chile's intelligence organization (CNI, Central Nacional de Informaciones) began using computers to record and document opposition groups and coordinate with other South American repressive regimes. At the same time, in 1979, the Catholic Church created a system to help people and document human rights violations by developing a database system to support lawyers in their related cases. (Álvarez & Gutiérrez, 2012: 30)

During the upcoming decades, passing through the Pinochet's government to the democratic periods started at 1990, computing becomes a discipline strongly focused in economics, trade, administration and management. Engineering, scientific and technological applications were developed within universities and private sector as well.

3. Second stage, through the 70's: the suitable context for the first musical attempts

3.1. Formas

It was within the fertile interdisciplinary ethos of the last 60's and early 70's that the idea of using computers for art came true. The necessary base equipment, the technicians, the programmers and the musicians were ready for action. Is important to remark here that this 'action' would not have started without the active people interested in do it and whom was open minded to facilitate this flow of research and musical creation. This crucible stood at the Universidad de Chile and connected the Department of Physics of the Physics and Mathematics Sciences Faculty and the Studio of Musical Phonology of the Arts Faculty.

After a prolific career in Chile, Germany and Venezuela, José Vicente Asuar (1933) started to develop the crossover of music and technology in the Universidad de Chile in 1969 funding the new academic career of Sound Technology, which aim was to give formal education on these topics, giving both technical and artistic skills to work in sound studios, cine, radio and television.

Asuar, who deserves an entire book due to his pioneering musical and technological work since 1958, was very aware of the interest of work with computers and at the same time of the state of the art at that moment. As many times before, Asuar started to study in a self-taught way the related issues: systems analysis, programming and computers structure and functioning among others (Asuar, 1975: 18).

Gathering and leading people of the Department of Physics and the new Music Technology career, Asuar started a collaborative project in 1970. Teachers and students worked with the IMB 360 computer to program it for compose music, forming the 'Group of Researching in Sound Technology' and carrying out the project 'Probabilistic Forms focused on musical creation' abbreviated as 'Formas I'. One of the main goals of the project was to allow the computer to replace as much as possible the human composer. With this idea in mind, the group

chose to program the computer to create within the conceptual framework of the contemporary music. This decision was made considering most interesting to get connected to the 20th century with eventual more creative results rather than do a project with a limited musicological interest given by classical styles. (Asuar, 1972: 51) It is arguable that Asuar wanted to differentiate from the Hiller and Isaacson's work, which he knew it well. So, despite that at the early 70's it was a moment of mutation and maybe decay for the style selected, the choice was to use techniques from Serialism, although the procedure was a derivation from this initial aesthetical source. The final tool was a probabilistic system that, according to Asuar, allowed to get results with similar sonic quality to the serialism but with a huger range of sonic and compositional possibilities thanks to little changes in the definition of elements and relationships. To the conventional control of all the parameters by the series (integral serialism), the group added the probability method to define any parameter (Asuar, 1972: 52-53).

For 'Formas I' it was used probabilistic distributions based in mathematical functions widely used in statistics and implemented through histograms and randomly numbers generators. Once the method was conceived, was translated to flowcharts after converted in programs to be processed by the computer. All the code was made on the language FORTRAN IV in the IBM 360 computer. The program contained 1000 instructions. The results were given in three types of numerics lists: one with the every detail for each layer of forming information (melodic, harmonic, rhythmic, unisons, silences, etc.), which is a analysis list to assign instrumentation and scenic location. A second numeric list with the details of the diachronic and synchronic information, namely the succession of tones as they appear chronologically: this numbers was translated to the score for each instrument, since 'Formas I' was devised as a work for ensemble. Both list had general information for sequences of musical material, including number of section, chromatic degree and octave, cue times for bars or bars fragments, their durations, intensity, dynamics, etc. (Asuar, 1972: 64-65).

The group left some decisions for the human agency: the computer gave 30 sequences (main structures), the staff selected some of them to transcribe into traditional score, according to personal criteria selecting the most interesting. Other aspects to be done by the composer or group were the instrumentation and all the aspects related to the speed, pauses, expansions and contractions of tempo (tempi, fermante, ritardandi, accelerandi).

Asuar transcribed the sequences 8, 17 and 21 for chamber ensemble. 'Formas I' was premiered in December 1st 1971 with musicians of the Symphonic Orchestra of Chile, conducted by Eduardo Moubarak (Asuar, 1972: 66).

3.2. 'El Computador Virtuoso': the IBM 360 controlling analogic synthesizers

During the first half of 1971, meanwhile the 'Formas I' project was in progress, Asuar completed a residency at the University of New York Electronic Music Studio in the Buffalo campus, thanks to a Fullbright scholarship. This internship allowed him to research on controlling analog synthesizers by digital computers with the supervision of Lejaren Hiller, thus realizing diverse experiences and tests, described in the technical report 'Programmed Control of Analog Sound Generators By a Digital Computer' (Asuar & Hiller, 1973). His work at the studio had other outcome, an acousmatic piece made with synthesis source materials: 'Buffalo 71', one of his most remarkable compositions.

With this researching experience and the background of the 'Formas' project, Asuar and the interdisciplinary crew undertake a new task, namely the control of analogic synthesizers by means of a digital computer.

Taking advantage of the new equipment at the Studio of Musical Phonology, in 1972 the project began to take shape. The central issue was use the computer not as a composer but as interpreter. The staff, directed by Asuar, was conformed by several students including Victor Rivera, whom was in charge of most of the work and central technical tasks, meanwhile Cristian Vergara, composition student, was involved on the main musical issues (Schumacher, 2005: 56). Through this project, Rivera obtained the title of engineer (Asuar, 1975: 19). Absolutely original, the project's staff created the necessary connection equipment, namely the Digital to Analog Converters (DAC). By these devices the IMB PDR-8 could control an Arp 2600 synthesizer (Schumacher, 2005: 56).

Driven by a pedagogical eagerness, Asuar lead the project in the way of classical music pieces performed by the computer on the synthesizers, trying to reach a wider audience. With the release of the LP 'El Computador Virtuoso' in 1973 the project effectively achieved to be known by more people. The 5 000 copies of the vinyl were sold out very fast. Alongside the pieces by Bach, Falla, Debussy, Ravel and Chopin, the LP includes an explanatory talk with didactic examples of the fundamentals of electronic sound synthesis and is one of the first worldwide editions on this issues. Asuar himself understood this album as a tool for education and the first half of a musical task more focused on creative applications for composition. (Asuar, 1975: 19) After decades, the LP becomes a classic of Latin-American electronic music, many times sampled by DJ's, techno and hip-hop artists.

After this historical moment, the rising Chilean computer music fell into a recess, due to the Asuar's gradual estrangement of the national scene, the great cultural cut induced by the *coup d'état*. Meanwhile, the contemporary music and specifically the electroacoustic one stay alive, weakly but enough to keep the flame in a windy age. Asuar continued working at the Universidad de Chile until 1975 and after was confined in his own private studio, working as engineer and travelling continuously between Chile and Europe; precisely in 1975 he won the first prize at the Bourges competition for his work *Guararia Repano*, a classic of the international electroacoustic repertoire. This is relevant considering that Asuar was the unique researcher for this area at that moment. Whereas the Chilean electroacoustic composition was weak in Chile, with the sporadic work by Juan Amenabar and by contrast healthy abroad due to the artistic labor by Gustavo Becerra-Schmidt, Gabriel Brnčić and Ivan Pequeño among others, Asuar kept the pace and getting ready to undertake a new challenge.

4. The ending of the 70's: the COMDASUAR

4.1. Context and sound source of the computer

The new challenge was an ambitious project for Asuar: to create an original computer, specifically designed to perform and compose music. With the experience obtained by his previous researches with computers and the recent knowledge, he began to work with the microprocessor INTEL 8080 as the core for the new machine that he conceived.

Started in 1977, during 1978, Asuar prepared and constructed the COMDASUAR (Computador Musical Digital Analogico Asuar or in English Asuar Digital-Analogic Musical Computer). Fully aware of the state of the art around the world and in the previous years, Asuar worked on his project regarding the background given by the achievements and investigations of Hiller and Isaacson, Xenakis, Mathews, and Chowning.

The goal pursued by the project was to get an instrument with a wide range of applications, including artistic aims, education and performing, all in public or private situations. The machine was unparalleled in his time: As a rule the computers were used as synthesis sources or as controllers of sound generators (synthesizers), as occurred with the 'Music' software family by Max Mathews for digital sound synthesis or mixing both techniques like the hybrid GROOVE system that blend digital and analogic (Collins & D'Escriván (eds.), 2007: xvii; Wang, 2007: 57-60). By contrast, the COMDASUAR integrates both worlds but through a small equipment, substantially cheaper and transportable (able of fit in the trunk of a car). Digital and analogic were blended by means of the attachment between the digital sound generator, namely the computer with a quartz oscillator, and a analogic section formed by several processing units to enrich the timbre, allowing in this way an enhanced color to the final sound. The quartz oscillator had a resonance frequency of 2.048 KHz and the audible pitches were obtained dividing the initial frequency by different ciphers, previously calculated in order to get the sub harmonics closest to the temperate scale (Asuar, 1980: 19). This original signal was a square wave allowing a polyphony of 6 voices in its first version and up to 15 voices in the last version of the computer in 1984 (video: *Temas – 1984 – Música Electrónica*, 2008).

The square wave was directed to a filter, for each voice, with voltage control, envelope generator and amplitude control. The control voltage values were obtained from a digital to analogic converter for each voice, connected in parallel. In the 1978 version, three of the six voices had a wave form generator: a demultiplex or that divided the square wave into 8 segments, lowering the pitch in three octaves (the original frequency was divided in 8 as well). According to Asuar, this segmented wave, processed by the filter, permitting to get very realistic imitations of real instruments by means of the variation of the first eight harmonics using potentiometers manually (Asuar, 1980: 22). Additionally, the computer had a complementary analogic equipment to generate effects: a white noise and a pink noise generators, two ring modulators, two tremolo generators, two LFOs to obtain voltage signals with sinusoidal, triangle and square forms to control filters and amplifiers, a phaser and other additional units like adders, inverters, multipliers, mixers and reverb. All of these units were arranged in a system of open connections, enabling many combinations to offer a wide range of sound colors (Asuar, 1980: 22-23).

4.2. The software: score reproduction and assisted composition tools

The original software allowed to reproduce any traditional score and also it could work as assisted composition tool by means of some specific programs. The software was coded by Asuar in machine language and had a size of 5 KB. It had 26 sub-programs ordered with the names of the alphabet from A to Z. Some of types of subprograms were: Computer commands (display memory in screen, delete screen, save in memory, changes data in memory, run programs), Musical data operations (enter data, change data, take off data, interpolation, transposition for pitches, transposition for durations), Sound export to analogic outputs, peripherics control (record

and read cassettes). But maybe the most interesting are the programs that Asuar called 'heuristic', which were the algorithmic tools for assisted composition: Canon, Retrogradation, Transmutation of pitches, Transmutation of durations, Probability and Insertion of durations group. All this programs were fixed in the ROM memory plus another algorithmic tools saved in cassettes, which are not described by Asuar in his texts (Asuar, 1980: 10) With a very simple syntax formed by combination of letters and numbers, the computer was capable of perform any musical style and the creation of new original pieces. At that period it was unthinkable to do some live coding, at least for Asuar, nevertheless he reserved for the human agency some actions in order to vary the flow of sound material coming from the computer. As Asuar states in a email:

> It was possible to induce an 'idle' state on the computer, which stops the CPU but allowing the Timer to continue delivering the last frequency before the interruption […] The tonality is altered by a potentiometer – transposing the tones – and another alterates the speed – acceleration and rhythm –. A knob interrupted the action so you can articulate what comes out of the computer by this way. The real-time control consisted in me hearing what the computer is delivering according to what the program develops, so with results that I did not know. As if I were the director of an invisible orchestra which give me music I never heard before, I can change the pitch, the agogics and the articulation of what I'm hearing according to the inspiration of the moment. I do not modify the code, but the results that the computer had delivered to me. Regarding the use of these procedures, I made many combinations and improvisations, some recorded to tape. I just translated into music one of these recordings and is within of one of the CD's of my works: *'Una Flauta en el camino'.*(Asuar, 2015)

4.3. Additional Hardware

The first version of the COMDASUAR was as described above, but by 1980 Asuar added a musical keyboard to enter musical data quickly and in a more organic way. Without achieving it, Asuar suggested in his article of 1980 that the next step it would be to connect the computer to different types of sensors to capture tactile data, temperature, light and sound in order to control the system in eventual projects involving not only musical performances but theatre and dance plays.

4.4. *Así habló el computador* and original compositions

Shortly after the construction of the COMDASUAR, the engineer and composer release a LP, *Así habló el computador* (*So speak the computer*) in a very similar mood of the previous one edition *El computador virtuoso*, that is a didactic record with explanations on the system and some classical pieces to demonstrate the capabilities of itself. This album becomes a classic in the history of electronic music in Chile and Latin America as well, being studied, analyzed and sampled across the years.

This pure pedagogical effort was just one side of his labor. The other was the composition of several pieces using his computer and from the early 80's combined with an Atari controlling a Yamaha DX7. From this period are the acousmatic-electronic compositions *Elegía* (1982), *En el Jardín* (1985), *En el Infinito* (1987), *Érase una vez* (1989) and *Cuatro Piezas Instrumentales* (1989). This group of late works were mostly created with synthetic materials from the COMDASUAR and some FM synthesis form the DX7 (specially the last piece) and as were

usual in Asuar's musical approach there is a combination of synthesis and recorded sounds in *En el Jardín.*

4.5. The oblivion… and recovery

The entire work of create the computer, release the LP, promote the project and compose original pieces was a completely independent endeavor without the support of any institution. Due to the non friendly and conservative environment within the Universidad de Chile, Asuar moved away from this space that therefore obviously doesn't have nothing to do with the COMDASUAR. As Asuar states in an interview: "I had no support to develop it in a teaching or research institution as I would have liked" (Bustos, 2012).

Without the academic, artistic and financial support, and being conscious of the fast obsolescence of his machine, Asuar didn't persist in the project, and gradually is shelved by its own creator. The sad and unfortunate situation was that the cessation of activities not only had affected the computer project but all the electroacoustic music research and creation of Asuar, whom by the end of the 80's will never compose or investigate again. Here there is an interesting and paradigmatic story to tell, but in other text due to its own value and extension.

Only from the beginning of the Twenty first century, the value and story of the achievements by Asuar will be rescued by a group of Chilean electroacoustic composers, especially thanks to the research of Federico Schumacher and the author of this article. The recovery was crowned with the release of the entire electroacoustic production of Asuar (with pieces from 1959 to 1989) on a triple CD edition in 2011 by Pueblo Nuevo, a Chilean label specialized in electronic and experimental music. Finally, in 2013 was premiered a documentary on Asuar and his whole work on computer, a prizewinner film by the Chilean director Carlos Lertora.

5. Gabriel Brnčić and Ronde Bosse

5.1. Brnčić: an historical referent

Gabriel Brnčić (1942) is one of the most relevant Chilean contemporary composers nowadays. With a wide catalogue of pieces covering diverse instrumental implementations and a huge amount of electroacoustic compositions, both acousmatic and mixed works, Brnčić is a permanent referent for generations of musicians and composers in Chile, Spain and the Spanish-speaking context, due to his strong educational labor as specialist in music technology. His enormous musical theoretical corpus and interesting life story is impossible to cover here. Formed in Santiago de Chile where studied violin and oboe and composition with Gustavo Becerra-Schmidt. He was enthusiastic on the new aesthetics of music and the new technological tools by the early 60's.

From 1965 to 1974 lived in Buenos Aires where studied and then taught electronic music in the magic artistic and intellectual crucible that was the Torcuato Di Tella Institut, working in the CLAEM (Centro Latinoamericano de Altos Estudios Musicales) and the subsequent CICMAT (Centro de Investigaciones en Comunicación Masiva Arte & Tecnologia).

Because the political situation of Argentina, he was forced to leave Buenos Aires due to his well known political commitment that made him an enemy of the Argentinean dictatorship. His

destination was Barcelona where he is based until this day. He started as teacher in the Phonos studio and becomes quickly its artistic director and then developed a fruitful pedagogical labor on composition and electroacoustic music in the Universidad Pompeu Fabra and the Escuela Superior de Musica de Cataluna (Schumacher, 2005: 43).

5.2. Ronde Bosse

Within this context, Brnčić developed an approach to composition that focuses on the rationalized structuring of the musical discourse, without a sharp difference between instrumental and electronic genres, although fully aware of their potential. He is having worked with matrices in the 60's in order to systematize the generation of materials, a way of thinking that will lead him to the use of algorithms (Schumacher, 2005: 45) Is important to note here that Brnčić always work with the resultant sound in mind, that is considering the tessitura and physical possibilities of each instrument, the computer, the tape or the synthesizers, thus distancing him from radical serialism positions. As Silvia Herrera states: "in the musical creation of Gabriel Brnčić predominates the concept of 'timbre in motion'. In his work is possible to speak of timbre rhythm, of a timbre harmony or better, of a timbre polyphony." (Herrera, 2005)

Having begun to code in the 70's, all this background decanted in the creation of his own algorithm, called 'Ronde Bosse' (High relief). This is a software that uses algorithms to create scores for instruments and sound synthesis as well, allowing to control several parameters and alternatives. The first piece were Brnčić used the algorithm was in *Polifonía de Barcelona* (1983), a mixed work for chamber group and live processing. From this period is the piece *Chile Fértil Provincia* for viola, bass, percussion, voice and tape, which won the fist prize in the Bourges competition of 1984. Since then, virtually all his compositions have created with Ronde Bosse, as a tool for generates instrumental scores, synthesis sound materials or to control real time sound processing.

An interesting collaborative project was the implementation of Ronde Bosse through a development framework for C++ called Rappid, an application for real time high demanding sound processing created by Enrique Robledo, Rubén Hinojosa Chapel and Maarten de Boer (Robledo *et al*., 2002: 1). Using the algorithm by Brnčić, the three members of the Music Technology Group of the Universidad Pompeu Fabra worked to generate the application that was used to implement sound morphing for a piece with the same name, *Ronde-Bosse* (2001) for viola and harp with live processing and fixed media (CD). The work was premiered at the Multiphonies 2002 cycle of concerts at the GRM in Paris. In the concert the software worked on a PC Intel Pentium III (800 MHz) with Debian GNU/Linux. The morphing mechanism was designed by Brnčić and consisted in a time domain envelope cross-modulation (Robledo Arnuncio, Hinojosa & de Boer, 2002: 224, pdf: 4).

Only remains to say that the huge catalogue of works by Brnčić deserves a review by its own merit and a detailed analysis of his algorithm with its technical and aesthetical implications as well.

6. Arrive of the personal computer: the home studio

Since the early 90's, the fast development in the home computer industry gave a new impulse to the field of computer music worldwide, including Chile. The cheaper hardware plus the emergence of powerful software tools gave a new momentum and fresh air to the discipline.

PC's, Apple Macintosh's, Windows, OS, Linux, Max/MSP, Supercollider, Pure Data, and a wide range of multitrack editing applications for audio and midi, filled the space of possibilities for musical creation. Moreover, the computer not only was the core of an electroacoustic music studio, becomes a complete studio tool, full of digital devices able to be used in interconnected arrays.

Chilean universities improve or implement electroacoustic studios where the computer is the central tool of work, study, analysis and creative development. GEMA at the Universidad de Chile, funded by the Chilean pioneer Juan Amenabar, LATEM at the Universidad Catolica de Chile and the LAIM at the Universidad ARCIS are only three examples of electroacoustic laboratories just in the capital. Considering the period between the 80's and the 90's, it should be assumed the many difficulties that the neoliberal system installation brought to the entire society in Chile, however it is notable the way how involved a slow access to technologies and different musical aesthetics:

> In the 70' s the production is small in Chile, although the quality of several works is undoubted with the winners of the Festival of Bourges: Asuar's "Guararia Repano" (1° place in 1975) and Iván Pequeño's "Ahora" ("Now", 2° place in 1974). In the 80's, things do not change much, and situation becomes doubly closed in the academic circuits: the structures stay and the military dictatorship forces or causes a retiringness mixed with an intellectual complexity that when moving away of the massive public assures the absence of the art's natural products: intellectual development and its derivatives: critical spirit and experimentation that moves to libertarian ideas. It is interesting to see that on one hand the military dictatorship maintains a relation of control and distrust with culture and art, generating official manifestations, by the other hand developed a neoliberal economic system that watched at the United States like paradigm. The market economy it did generate two factors: an economic system that little by little it would make possible to accede more and more easily to the technology, specially computer ones, and a culture opened to the manifestations of the pop music, which they filled progressively of electroacoustics techniques and even of own aesthetic ideas of this music. Recording techniques, synthesizers, sound effects and their musical particularities, before denied by an elitist structure, arrive at the massive public thanks to the rock, the pop music in general, the cinema and the television, all products of the increasing system of consumption in an *'american way'*. (Albernoz, 2007: 132)

So, with the institutional enhancement, the panorama is finally improved by the accessibility of home computers bought by the artists for their own private studios. All this created a critical mass that provided new generations of composers not only interested in electroacoustic and computer music, but creators proficient in the use of these technologies. For this reason, the different approaches to the computer music creation become very wide. Just a brief list of names and the musical path followed:

- Gustavo Becerra-Schmidt (1925-2010), one of the most important Chilean composers of the Twenty century, final works of instrumental music composed with sampled sound on a computer, related in some way to the ideas of Colon Nancarrow;

- Federico Schumacher (1963), acousmatic music;
- José Miguel Candela (1968) acousmatic music, mixed works, interactive music, experimental rock;
- Rodrigo Cádiz (1972), composer and engineer, works on instrumental, mixed, interactive, algorithmic, acousmatic music;
- José Miguel Fernández (1971) Mixed, acousmatic music;
- Roque Rivas (1975) Mixed, multimedia, acousmatic;
- Felipe Otondo (1972), acousmatic music, soundscapes;
- Antonio Carvallo (1972), mixed music, acousmatic;
- Daniel Osorio (?), mixed music;
- Renzo Fillinich (1978), live electronics, acousmatic, mixed music;
- Bryan Holmes (1981), mixed, live electronics, multimedia, acousmatic;
- Marcelo Espíndola (?), acousmatic music;
- Cecilia García-Gracia (1968), acousmatic music, mixed music;
- Esteban Agosín (1984), multimedia, sound art, interactive, mixed, acousmatic music;
- Aurelio Silva (1988), acousmatic and mixed music;
- Félix Lazo (?), algorithmic, multimedia, live electronics;
- Alejandro Albornoz (1971), acousmatic music, sound art.

This is just a short list of composers and is provided to show the variety of musical interests addressed by means of computer as a central axis of creation. These composers follow different technical paths and compositional approaches as well: assisted composition, algorithmic composition in live situation, sound live processing, sound design, acousmatic composition, multimedia and interactive pieces, audiovisual works, etc. The use of open source tools is another factor to be analyzed regarding the artistic aspects involved and the socio-cultural implications as well.

In terms of a particularly algorithmic computerized trend, is necessary to remark here the work by Rodrigo Cádiz and Felix Lazo.

Cádiz, PhD in Music Technology from the Northwestern University (USA) and Civil Industrial Engineering with major in Electrical Engineering and Bachelor of Music with major in Composition from the Pontificia Universidad Católica de Chile, has a profuse work with computers, algorithms, neural sensors, development of new interfaces and synthesis methods, both as researcher and composer (Rodrigocadiz.com, 2015).

Meanwhile, Lazo with BA in Music at the Pontificia Universidad Católica de Chile, studies in Biology, Visual Arts and specialization in Computer Music Composition at the Center of Musical Composition, Iannis Xenakis, Paris, has a important career as visual artist in Chile and Latin America, develops a wide range of outcomes, covering paintings, drawings, installations, algorithmic music and video, live electronics performances and sound installations. It is interesting how Lazo transfer some specific concepts of Humberto Maturana neuroscience work to his music and audiovisual works, particularly the notion of ‘autopoiesis’ manifested in his series of works precisely entitled in general as ‘Autopoietic systems’ (Lazo, 2012: http://www.lazo.cl/LazoCV2012.html).

Conclusion

With a strong and interesting beginning in the 70's, the field of computer music in Chile shows a curve that grow up fast in these early years thanks to the Asuar leadership, an equally rapid decrease due to lack of interest, the conservatism in the Chilean dictatorship period and finally a rebirth thanks to the emergence of cheaper and accessible hardware and software since the 90's. This arc of development reflects, in our vision, a worthy movement, very complex in its components and ramifications, but which can be simplified in a motion from the altruist, multidisciplinary and naif first years, through the silence of the terrible years of non democracy to finally arrive within the capitalism frame where the fruits of the neoliberal commodification of every aspect of life is processed by the composers, allowing music to go beyond this specific context. From this point it just needed to analyze how the use of computers implies the expression of particular music aesthetics or how the well-known types of approaches go beyond their own bounders.

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