Structs for an Aspatial Quantum-Now

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Abstract

Human structure, in the now of the space-time fabric, has been a millennial subject of metaphysical constructs which try to account its full latitude, scope and mechanics. Concepts like *Actual* and *Virtual, Time-Crystal, Immanence Plane* (Deleuze), *Gaia* (Lovelock), *Aleph* (Borges), *Dharma* (Buddhism), seemingly attempt to look closely, feed-back and expose the perception mechanism on top of which the lowest levels of reality are perceived, also akin to the structure of the universe and life itself, at its tiniest and largest scales. Through the use of rules on programmed computers, which will be exposed and compared to metaphysical concepts, it is possible to create devices which set afoot first-steps towards practical experimentation and tangibility of such consciousness-spaces. Developed since 2000, the 11 works in the *Struct* series of audiovisual interactive installations, by sampling the now and raycasting traces from the past into the present, create aesthetic compositions and experience-spaces that pierce through the artistic realm into an experience-space which exposes an aspatial quantum-now.

Introduction

Struct (Sier 2000-) is a series of interactive artworks I have been developing since 2000. One of my first purely computational audiovisual work series and among the first real-time interactive installations. These artworks seek to paint and sculpt in interactive media the human perception mechanism, on top of which the lowest levels of reality are perceived. They provide continual audiovisual synesthetic composition-spaces performed only on sampled site-specific visual and

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auditory data which is orchestrated by programmed generative or visitor manipulated algorithms. The works are aimed at creating experience-spaces where the observers can dialogue and immerse with themselves and/or previous user fragment sampled debris. Through these installations, users can see dynamic paintings, sculptures, experience-spaces inspired in the way by which we apprehend exterior reality through senses. Self-referentiality reverberation chambers, the works amplify a nothingness that lingers and persists on any space experienced over time by an observer, and use that substrate as compositional means to orchestrate an ever new experience to any visitor.

The title of the series derives from two main uses of the word *Struct* in relation to these art works. On the one hand it is a diminutive of structure, being that which lays the foundations on top of which phenomena are experienced, like the structure of the human perception mechanics, usually referring to an invisible inner shell that allows shape's or certain form's existence, or the apprehension of certain phenomena within a sense domain. On the other hand, *struct* is a C programming language keyword that defines a compound data type made from previously defined types made aware to the compiler. It's a programming concept which forms a bridge towards OOP (Object Oriented Programming) to facilitate a higher-level programming language. It binds distinct variables from possibly different data types under one symbol in this newly formed data type aggregated from previously defined ones towards easing meaningful data storage and processing within the program, while escalating complexity (Kernighan and Ritchie 1978). It mainly serves to group and fly data around the program through functions and memory registers in a higher level which can harbor increasingly complex algorithms. The struct programming definition also touches the core of what synesthetic phenomena are like: one can aggregate under one struct the mechanics by which to transform sound into image, or any other sense data transcription and combination, like synesthetes often expose rules of how they see certain shapes or colors when hearing certain sounds, among many other examples of synesthesia.

The *Struct* series was born out of necessity to deepen previous preliminary artistic work which real-time shifted the sound of a space to another, and synesthetically used the sound to vibrate water enclosed on a woofer, generating real-time sound generated water based forms. The water surface patterns on the sound woofer were transformed and amplified into synthesized light that undulated according to the patterns of the frequencies emitted in the woofer, using light projection on the water surface and reflecting it side by side with the woofer by using a mirror. This early work formed the base path of research and investigation of the series *Struct*.

Figure 1: *Je t'aime...* (1998). Microphone, amplifier, modified woofer, water, light, mirror.

With a background in musical and visual arts, sciences and philosophy studies, delving deep into

computation and programming at the time, it seemed obvious to me to expand, deepen and refine this experiences by adding algorithmical processes. Not just by using real-time synesthetic transcriptions, but to expand this process and develop a signal processing language that could operate only on sampled real-time captured fragments on the computer. The aim of this *Struct* language would be to synthesize any sounds, timbre, dynamics, visual flows by using only real-time found and sampled fragments of aural and visual data the users would provide the devices. Using feedback and other time-based signal processing operations on the site-specific aural and visual data, it came to my mind that the computer could be orchestrating perpetual arrangements at shifting speeds of distinct and previously sampled audio moments, and that this could be an original means by which to synthesize any kind of sound and or visuals. On the other hand, the computer could also help to automate and create generative emergent algorithms to control the synesthetic processes, by fading in and out lights according to the real-time sound levels, by synthesizing audio and motion reactive seamless virtual visual limitless spaces. To expose an infinitude of orchestrations, like machines weaving processes on the residual data that emerges from the void of the contact of people with the works themselves. A full synthesis language that uses solely sampled aural and visual fragments, and re-injects these previous fragments processed into the now. The resulting sonic and imagetic output the pieces generate, triggered by sounds or movements performed in the experience-space by the visitors, are then re-casted onto the mechanism, re-transformed into input samples, caused by natural feedback of sampling machines that broadcast continually, sampling the exterior and themselves.

Already after having developed the earlier two *Structs,* I became acquainted with similar art works which have influenced this series path. John Cage's 4'33'' (1952), Nam June Paik's TV Buddha (1974), Bruce Nauman's Live-Taped Video Corridor (1970), Johann Sebastian Bach's Fugues (1722-1742[3]), among others, have been key works which resonate with the themes I was deepening in the *Struct* series. All these works share a common main theme. Recursion, self-reference, evolving unique synthetic languages based on small samples from reality, fractal regions, whereas small temporal or spatial regions share main characteristics of the whole or larger regions, at different zoom scales, in a *hors-temps* and *hors-espace* domain. While the first three mentioned works focus on showing the open, or provide simple real-time transcriptions of visual data embedded into different images, Bach's fugues showcase remarkable counterpoint techniques where a simple melodic composition line becomes fractal and is combined with itself at different pitches, speeds, layered from single melodic lines to 2, 3, 4, 5, 6 simultaneous voices orchestrating melodic counterpoint variations of a main musical theme. Such is the case of the *Musical Offering* (Bach 1747). In this work Bach composes one of the most elaborated and complex fugal compositions, sometimes with 6 distinct voices, from a harsh themed melodic line provided by king

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3   The time interval refers to the publication dates of the two books that comprise *The Well-Tempered Klavier* that round preludes and fugues written by Bach in all possible 24 major and minor keys. The first book was completed in 1722 and second book twenty years later in 1742.

of Prussia Frederic the Great. As Douglas Hofstadter (1999:9-10) accounts for:

> A fugue is like a canon, in that it is usually based on one theme which gets played in different voices and different keys, and occasionally at different speeds or upside down or backwards.[...] Each of the voices enters in turn, singing the theme, often to the accompaniment of the countersubject in some other voice, with the remaining voices doing whatever fanciful things entered the composer's mind. When all the voices have "arrived", then there are no rules. […] These successive modulations lead the ear to increasingly remote provinces of tonality, so that after several of them one would expect to be hopelessly far away from the starting key. And yet, magically, after exactly six such modulations, the original key of C minor has been restored! All the voices are exactly one octave higher they were at the beginning, and here the piece may be broken off in a musically agreeable way.

This could also be looked at by another and more contemporary perspective. In any signal processing system, a self-reference process usually involves the feedback equation, where a percentage of the output/processed signal is added at the beginning of the system towards further processing, cascading and percolating a systemic loop, generating a themed phrase from rules applied to a short input signal which reverberates across the system. The percentage amount usually correlates to the feedback factor of the system. But mathematicians have shown us that these self-referenced recursive structures can also exist beyond the feedback process. Fractal systems, for instance, possess similar spatial and time qualities of feedback or fugal processes. Chaotic attractors and cellular automata also underline an emergent mathematical process which gives rise to complex patterns often found in nature (Gleick 1994). These algorithms expose a general form enclosed and self-referenced within the overall shape, shaped by a functor processing wave on the signal itself. A form that gets repeated, trans-scaled, pitch-shifted along side and at every scale of the mathematical system. As Hofstadter remarks on *Godel, Escher and Bach* (1999:10), this recurrence and fugal structure is the basis process of emergence of consciousness, of Strange Loops*: The "Strange Loop" phenomenon occurs whenever, by moving upwards (or downwards) through the levels of some hierarchical system, we unexpectedly find ourselves right back where we started.*

Aspatiality and quantum-now

Extensive space lays the foundational core for the existence of experiences and beings we as humans experiment. We experience no other kind of space. We are always embedded in a glade, even if it is an empty white box, it is still extensive and has standard departure spatial characteristics which frame any event or thing. It's next to impossible to conceive of void space. Yet molecular space, or cosmic space, or mathematical space, any kind of space which exceeds our natural apprehension mechanism is overlooked by our abilities to perceive it. And to add to this, physical rules differ in very tiny or very large spaces. For example, gravity, time, space, experienced on the surface of the earth at a human scale are largely distinct from the same concepts at a cosmic or even

molecular levels. Also related, how would we add tangibility and extensiveness to imaginary spaces? In the context of this research, these could be twofold: imaginary spaces built by the human mind, i.e., the omni-present virtual plane in the actuality of the human (Deleuze 1968), or the complex plane in mathematics, made by a conjugation of real and imaginary numbers to form a special imaginary plane quite helpful to solve everyday physical problems (Struik 1989).

There are also other possibilities of spaces. For instance *non-places* (Augé 1995): *an ever increasing proportion of our lives is spent in supermarkets, airports and hotels, on motorways or in front of TVs, computers and cash machines...* Non-places however are distinct from no-places, or *aspaces*, to follow the proposed term of *aspatiality* which relate to the spatial characteristics of the *Struct* series (Sier 2000-). Non-places do share a common characteristic to aspatiality which is a common irrelevant physical extensiveness that serves as basis to be elsewhere, an effective transport space which allows immersion in a more appealing virtual, endowed by the substract. However they can be distinct in the sense that aspatiality points to a zeroth extensive space – no space – yet capable of seeding and engendering any and all spaces – the possibility of space, of any space, in zeroth extension, capable of hosting the full actual and virtual bodies. In this *aspace* any distinct and unique configuration of matter elements can be aggregated into extensive shapes that come into existence from a void. Aspatiality tends to an actual zeroth extensive space, though never fully reached, tendentiously free of referent and resilient actual images, as wide open as possible to any virtual concrete spatial configuration, an extensive near nothing which houses the infinitude. It is a concept inspired by Jorge Luis Borges' *Aleph* (Borges 1998:646):

On the back part of the step, toward the right, I saw a small iridescent sphere of almost unbearable brilliance. At first I thought it was revolving; then I realised that this movement was an illusion created by the dizzying world it bounded. The Aleph's diameter was probably little more than an inch, but all space was there, actual and undiminished. Each thing (a mirror's face, let us say) was infinite things, since I distinctly saw it from every angle of the universe. I saw the teeming sea; I saw daybreak and nightfall; I saw the multitudes of America; I saw a silvery cobweb in the center of a black pyramid; I saw a splintered labyrinth (it was London); I saw, close up, unending eyes watching themselves in me as in a mirror; I saw all the mirrors on earth and none of them reflected me; […] I saw the Aleph from every point and angle, and in the Aleph I saw the earth and in the earth the Aleph and in the Aleph the earth; I saw my own face and my own bowels; I saw your face; and I felt dizzy and wept, for my eyes had seen that secret and conjectured object whose name is common to all men but which no man has looked upon — the unimaginable universe.

Similarly to space, time is a fundamental category by which phenomena are experienced. But the time of entangled loops on hierarchical systems, the time of the substrate of the human mechanics of apprehension, the time of pre-conscious human flows where sense data turmoils and gladiates for consciousness control has peculiar characteristics when observed, if possible to observe, at a granular microscopic level. This time which houses numerous systemic directions, flows, overwhelming forces and intentions of humans in a pre-conscious state is similar to a space that can harbor infinitude of spaces. In its essence, it is similar to what Deleuze calls Crystal-Image (1983)

when theorizing about cinema and moving images: *a representation of the splitting of time, the movement of past and present reflected through these images.* Deleuze states that *cinema does not just present images, it surrounds them with a world.* Like any individual frame holds invisible links to all the past frames, as well as all subjectivity evoked by what is and what is not shown on the images. A crystal through which the stratified layers and points of view gain shattered and fractal visibility.

Looking this close on time, there are inevitable links to the quantum physics world. In quantum mechanics, the analogue of Newton's laws, which are sufficient in describing natural systems at human scales, is the Schrödinger equation for a quantum system. This is the world of atoms, molecules, and subatomic particles whether free, or bound in aggregates. And the Schrödinger equation attempts to describe it precisely. It is not a simple algebraic equation, but in general a linear partial differential equation, describing the time-evolution of the system's wave function (Schrödinger 1926). Quantum-now might be a derivative of the time instant that is flowing, tendentiously a zeroth derivative, like performed earlier for the spatial domain. Here, the sampled instant, according to the sampling device's precision, contains within the actuality of the event the full or partial spectrum of possibilities attached to it, much like a Deleuzian crystal-image.

There are also unequivocal similarities to the structure of how a fugue is edified and performed, departing from a motif, cascading voices which sample and rework the theme, layering them in the now to orchestrate a certain mode of being, or a fleeting feeling, a musical idea. Or how we humans read books, grasping ideas, following words in linear fashion to understand a meaning. But in its essence, the reading act, at a subliminal near instant level, is a non-linear sequential fractal reading, where one jumps across, cuts, blends, mixes, reverberates, hears two or more voices at different speeds. This is related to how the virtual is always driving and shaping the actual on the human, and no objective exterior experience can be obtained without the mark of the observer's machine sampling it.

This elusive structure, in the aspatiality and quantum-now of the void, when reflected through a void, besides unveiling an apparently infinity of possibilities, overwhelmingly sculpts the perceptive machine of the one that observes and lives and interferes within the field. Like Xenakis' ontology of an immaculate synthesis (1992:24):

> *In a universe of nothingness. A brief train of waves, so brief that its beginning and end coincide (negative time) disengaging itself endlessly. Nothingness resorbs, creates. It engenders being.*

Structs

The pieces that compromise the *Struct* series attempt to discourse about this infinitude out of nothingness, in the auditory and visual domain, installed in a space at human scale of experience. When immersed in the aural and visual experience of the piece's space, users travel elsewhere, only to find themselves later traveling within a painting of their own perception of space and time, embedded in a continual composition engendered by the programmed rules, the machine's decisions, the exterior sampled events. The spaces and events the pieces facilitate pierce the space they are installed at to showcase a recursive space-time continuum built as a simile of our own perceptive apparatus.

Interactive art installations that provide the means to develop machine-observers, other than human entities, which endlessly compute and blindly execute algorithms running on machinal substractes. The *Structs* sample the now and raycast traces from the past into the present, whether in the audio or visual domain, creating these experience-spaces that pierce through the artistic realm into an experience-space which exposes an aspatial quantum-now.

The works build self-referentiality reverberation chambers which amplify a nothingness that lingers and persists on any space experienced over time by an observer, and use that substrate as compositional means to orchestrate an ever new experience to any visitor.

Struct_0 (2001), *Struct_1* (2001), *Struct_2* (2002), *Struct_3* (2004) are audiovisual programs that share a similar audio processing engine. Eight buffered voices alternate in sampling the aural site-specific space when the captured sound levels exceed a certain threshold. The buffers are played back with stochastic shifting speeds and sound levels. They also operate as base sounds for an autonomous granular synthesis engine that punctuates the sonic composition. Delays with feedback are also used on the direct samples or the processed ones. While on *Struct_0* these sonic processes are autonomous and stochastic, *Struct_1* and *Struct_2* offer a control panel to the users to allow real-time composition of such audio processes. All generated sound is analyzed and used as synesthetic control parameter for the image synthesis. On *Struct_0* the visual elements are composed by a lines particle system which is highly organic in movement to the sonic variations; on *Struct_1* and *Struct_2* a parametrized segmented rectfield capable of being tinted with current and previously sampled images is the central base shape for the multitude of screens that occupy the graphics viewport. In the *Struct_3* program, besides the buffered microphones aural composition there is a synthetic section that applies the same stochastic engine to an FFT (fast fourier transform) numerical analysis of Pergolesis' *Stabat Mater* (1736). And the resulting composition is spatialized to a quadriphonic audio setup according to several mathematical movement equations of displacement.

Figure 2: Struct_0 at *Apertura 1.0: seis proyectos digitales en el MEIAC,* Sevilla, 2001.

Struct_0 is an audio-visual site-specific installation/composition. It is an informatic application that seeks to visually expose the subjective aural tissue of a space under the shape of particle systems synthesis in "audible" sinthony with the composed sound. Audio-visual site-specific painting. (Sier 2001)

Figure 3: Struct_1 at *META.morfosis / MEIAC,* Badajoz, 2006.

Struct_1 is an audiovisual app that explores the concepts of time and space-, time in the 3 possible tenses (what was, what is, what will be) and a spatial metaphor of the consciousness as a segmented rectfield capable of being tinted with quicktime movies, stills. Visually, and audially it is a sort of a polyphonic time sampler that percolates the audio input stream into 8 buffered voices, colliding all of them into the present at shifting speeds. The final audio energy values tint structure modifications. The image engine seldomly captures frames from the user visual navigation feeding the data into the past module image buffer. Something like life... (Sier 2002)

Figure 4: Struct_2 screenshot.

Struct_2@Pavilhão 21C is the result of the collaboration between a resident at Hospital Júlio de Matos (a state psychiatric institution) and my Struct systems applied in a real-time site-specific context. Its goal: to explore intimate notions of space and time in a collaborative fashion through the minds that heal silently, exhausted of western society, through invisible technology. (Sier 2003)

Figure 5: Struct_3 screenshot.

Struct_3 generative audio-visual multi-temporal/spatial explorer. the spirit is profuse and encounters regions where it diffracts through the space, percolates the temporal instants, flies over in many ways the same reality. the mind of heraclitus meats dante stratified over benjamin's abstract places. struct_3 is the ubiquitous moment, ancient, of lousing / finding the self ([id]) passage from solid to gaseous, where the temporal tissue unravels like infinite, percolating, liquid-made, abstract. all is open. (Sier 2004)

Struct_4 and *Struct_5* (2006) return to the visual synesthetic transcription of sound being broadcasted on modified woofers with liquids illuminated with lights, with similar stochastic audio engine operating on 4 and 3 channels of audio respectively. *Struct_5* is the first struct installation to apply visual movement in front of the piece as control mechanism for the whole audiovisual composition.

Figure 6: Struct_4 at *XIII Biennale for Young Artists from Europe and Mediterranean,* Bari, 2008.

Struct_4 is an audio-visual device that flows together sound moments gathered in four different microphones attached to four modified woofers with liquid producing patterns that are amplified through lights and mirrors.

Figure 7: Struct_5 at *Artescapes, Universitat Politècnica de València,* València, 2007.

Struct_5 is an interactive device that captures and interferes with the sound and visual motion that occurs in a site-specific space. the installation creates an image of movement of the space into a forest of video planes that sculpt three dimensional space. the data gathered from the movement controls the broadcast of sounds being sampled real-time from the microphones.

Struct_6 (2007) is the first purely visual with no sonic output mechanical installation which reverberates the same ideas from the struct series, using a simple arduino micro-controller to orchestrate movements on the camera. *Struct_7* (2007), *Struct_8* (2008), *Struct_9* (2011), *Struct_10* (2015) are struct pieces that make again use of the computer and only cameras and visual output as means to engender experience-installation-spaces which resorb around the nothingness they depart from.

Figure 8: Struct_6 at *Objecto: Simulacro, Pavilhão 28 Hospital Júlio de Matos*, Lisboa, 2007.

Struct_6 is a vibrating feedback machine suspended in elastics, with a camera aimed at two televisions and two mirrors. two motors induce vibrations in breeding like patterns.

Figure 9: Struct_7 at *Stream, White Box*, New York, 2007.

Struct_7 is a camera based immersion in visual environment. abstracting the space of the flow of a river, where the viewer interacts with time debris of previous viewers scattered in 3d flowing space.

Figure 10: Struct_8 screenshot.

Struct_8 is an audio visual camera based immersion. 3 parallel time-based processes are interactive to

movements.

Figure 11: Struct_9 at *uunniivveerrssee.net, Museum of São Roque*, Lisboa, 2011.

Struct_9 is a camera based immersion in visual environment. abstracting the space of a wall, where the viewer interacts with time debris of previous viewers scattered in 3d flowing space.

Figure 12: Struct_10 at *Radiotelescópio, Zaratan*, Lisboa, 2015.

11th piece of the struct series, using only site-specific inputs, composing with now and past moments, playing with space and time constructs. struct_10 is an interactive camera based immersion in 3d visual environment where the viewer interacts with the generative motion mechanics and is recorded along side with time debris of previous viewers scattered in 3d flowing ever changing space.

Conclusion

These *Structs* are machines sampling aural and visual elements taking place in an enclosed limited domain, seldomly populated by viewers. Viewers observe and interact with the work, but the works' content is simply made from sampled visitor's sensitive fragments in reality, their visual appearance and performed movements towards cameras, the sounds they emit in the space captured by microphones, the feedback they receive from the pieces' algorithms playing with their inputs.

Coding and installing practical mechanisms which deepen and paint the ideas related to how and why the human perceptive apparatus may work are a flourishing theme and blooming art science field, with some rare examples throughout art history. They can serve as tools to deepen consciousness-spaces and provide simple playful mechanisms to unconsciously self-reference the observer. One can also look at the healing psychological potential of such spaces as a future line of work in caring for more fragile minds.

They are works dealing with perception mechanisms, where the quality of apprehension of phenomena and the observer machine that apprehends it is the theme of the work, as opposed to subjective fully exterior phenomena being the main theme. But this intensive look on the observation disregarding the observed can only be achieved through phenomena, pointed at itself, tendentiously without other stratification or contribution of alien elements.

By building dynamic systems where self-reference and tangled hierarchies are the subject, one gets closer to a sympathetic reverberation with the perceptive and intelligent systems of the observer himself, without the necessity to introduce additional exterior content. Even so, formal rules and self-reference allow systems to acquire meaning despite being made of meaningless elements.

In the midst of the quiet or the cacophony of the current composition offered by the running programs, the works can thus pierce identitarian limits within the observers while opening glades of infinitude before their selves. They may find echoes and fugal like structures sympathetic to their actions, where their own movements become central motifs in the score of the pieces. An experience-space pointed towards an aspatial quantum-now.

References

Augé, M. (1995), *Non-places: introduction to an anthropology of supermodernity,* London: Verso.

Bach, J. S. (1747), *Musical Offering,* [composition], Potsdam: Sanssouci.

Borges, J. L. (1998), *Obras Completas de Jorge Luis Borges 1923-1949,* Lisboa: Editorial Teorema.

Cage, J. (1952), *4'33",* [composition], New York: Woodstock.

Deleuze, G. (1968), *Différence et Répétition*, Paris: Presse Universitaires de France.

Deleuze, G. (1983), *Cinéma 1. L'Image-Mouvement*, Paris: Les Éditions de Minuit.

Esparcia, A., Urbano, P. (Eds.) (2007), *ArtEscapes: Variations of Life in the Media Arts, c*atalogue of exhibition at Universitat Politècnica de València, 11th April - 18th May 2007, Valencia: Editorial de la UPV.

Gleick, J.(1994), *Caos: A construção de uma nova Ciência,* Lisboa: Gradiva.

Hofstadter, D. (1999), *Godel Escher Bach - an eternal golden braid,* New York*:* Basic Books.

Kernighan, B. W., Ritchie, D. M. (1978), *The C Programming Language*, Englewood Cliffs, NJ: Prentice Hall.

Nauman, B. (1970), *Live-Taped Video Corridor*, [video installation], Los Angeles: Nicholas Wilder Gallery.

Paik, N. J. (1974), *TV Buddha*, [video installation], New York: Galleria Bonino.

Pinto, A. C. (2001), "MEIAC_GV 1.0 - transição e tecnofania", in *Arte portugués Contemporáneo/Argumentos de Futuro. Colección MEIAC, Museo Extremeño y Iberoamericano de Arte Contemporáneo,* Badajoz: MEIAC.

Ponciroli, V., Guidetti, L. (Eds.) (2008), *XIII Biennial of Young Artists from Europe and the Mediterranean – Puglia 2008,* Milan: Electa.

Schrödinger, E. (1926), "An Undulatory Theory of the Mechanics of Atoms and Molecules", in Physical Review 28 (6): 1049–1070.

Serres, M. (1997), *As Origens da Geometria,* Lisboa: Terramar.

Sier, A. (2000-), *Struct series,* [interactive installations], http://andre-sier.com/struct. Accessed 1 May 2017.

Sier, A. (2001), *Struct_0 user manual,* http://andre-sier.com/struct/struct-0/. Accessed 1 May 2017.

Sier, A. (2002), *Struct_1 user manual,* http://andre-sier.com/struct/struct-1/. Accessed 1 May 2017.

Sier, A. (2003), *Struct_2 user manual,* http://andre-sier.com/struct/struct-2/. Accessed 1 May 2017.

Sier, A. (2004), *Struct_3 user manual,* http://andre-sier.com/struct/struct-3/. Accessed 1 May 2017.

Struik, D. J. (1989), *História concisa das matemáticas,* Lisboa: Gradiva.

Xenakis, I. (1992), *Formalized Music: thought and mathematics in composition,* Hillsdale NY: Pendragon Press.

BIO

André Sier is an artistic engineer with training in sciences and arts, and a degree in philosophy. Working since 1997 at s373.net/x studios, exhibits and performs works worldwide, with more than 25 solo exhibitions and over 80 participations at collective shows, festivals and artistic events. Sier works with code, 3D, video, sound, electronics, drawing, sculpture, videogames. Through algorithmical structures and custom human interfaces, he creates objects and serial interactive work which playfully seeks to unravel time and space relations, as well as to propose a seamless infinite virtual imaginary cosmogony synthesized on electronic substrates which could rival reality. Awarded at Jovens Criadores (2006), Bienal de Cerveira (2009), three times at Lisbon MakerFaire (2014,15,16), Sier underlines the series 'Struct', '747', 'space race', 'k.', 'uunniivveerrssee', 'piantadelmondo' and 'wolfanddotcom'. Regular teacher of electronic interactive arts since 2002, invited assistant professor of digital arts at Universidade de Évora, he is currently doctoral student at Planetary Collegium.