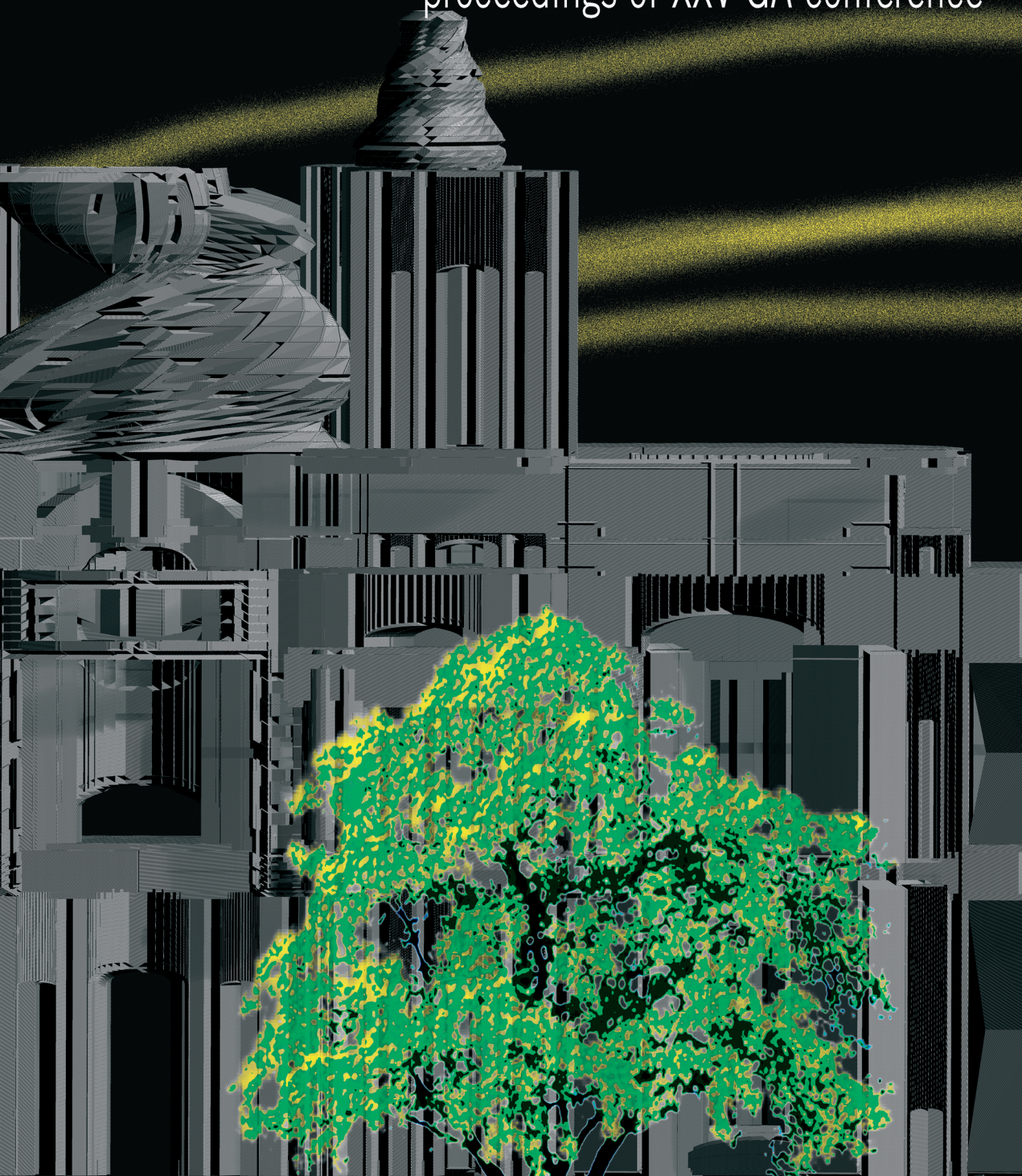




XXV GENERATIVE ART 2022

proceedings of XXV GA conference



edited by

Celestino Soddu, Enrica Colabella

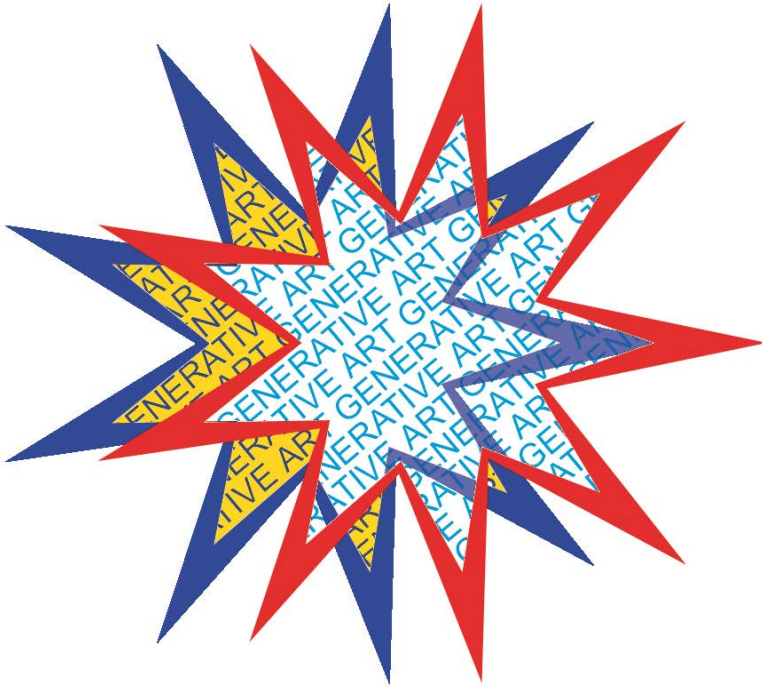
The book contains the papers, installations, posters, artworks and live performances presented at XXV Generative Art conference at the Borrominian Hall of Biblioteca Vallicelliana, Rome, Italy.

In the cover a generative interpretation of the Borrominian facade of Oratorio dei Filippini, made by Celestino Soddu.

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GENERATIVE ART 2022

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*GA2022 is organized by Generative Art and Design Lab, Argenia Association,
Roma, Italy*

Proceedings

Edited by Celestino Soddu and Enrica Colabella

INDEX

Page 5

Celestino Soddu, Enrica Colabella, Italy, Chairs of Generative Art conference, **OPENING**

PAPERS, VIDEOS and ARTWORKS

Page 15

Celestino Soddu, Italy, Generative Art & Design Lab, Argenia, **GENERATIVE ART AND DESIGN. VISIONARY ALGORITMS FOR A NATURAL COMPLEXITY**, paper

Page 21

Adam Fung, Nick Bontrager, USA, School of Art, Texas Christian University, **PRINCIPLES OF DESTRUCTION (EMERGENCE)**, video

Page 23

Ahmed Abdulwahid Taha, Oday Qusay Abdulqader, Iraq, Department of Architectural Engineering, Mosul University, Mosul,, **THE ALGORITHM OF GENERATING ALTERNATIVE MODELS FROM THE HERITAGE HOUSES' GATES IN OLD MOSUL CITY**, paper

Page 30

Alain Lioret, France, ESGI Digital Lab, **QUANTUM BEINGS**, paper

Page 37

Amer Abdullah Alazawi, Oday Qusay Abdulqader, Osamah Hammadi Ali, Iraq, Department of Architectural Engineering, Mosul University, Mosul,, **THE GENERATING PROCESS OF ALTERNATIVES OF CONTEMPORARY FACADES FORMS FOR HOUSES**, paper

Page 44

Andre Kudra, Germany, AoC Initiative, Germany, Echtzeit – Digitale Kultur, Switzerland, Computerkunst e. V., Germany, **DEMOSCENE DISPLAY INSTALLATION**, installation(video)

Page 46

Angela Ferraiolo, USA, Visual and Studio Arts, Sarah Lawrence College, Bronxville, New York, **ZEBRA: THREAT AND RESPONSE IN A DYNAMICAL ARTWORK**, paper

Page 49

Anna Ursyn, Stuart Smith, USA, School of Art and Design, University of Northern Colorado, Computer Science and Music, U Mass, Lovell, **URBAN CODES**, artwork video

Page 50

Arne Eigenfeldt, Canada, School for the Contemporary Arts Simon Fraser University, Vancouver, **A WALK TO MERYTON**, paper and video installation

Page 62

Celestino Soddu, Italy, Generative Art & Design Lab, Argenia, **ABDUCTION FROM BORROMINI. GENERATIVE INTERPRETATION OF THE FAÇADE OF “ORATORIO DEI FILIPPINI”**, artwork

Page 65

Chad Eby, USA, School of Art and Visual Studies, University of Kentucky, Lexington, KY., **MODULARITY AND GENERATIVE ART**, paper

Page 74

Chin-En Keith Soo, New Zealand, University of Waikato, Department of Design, (**CO - WARE**), artwork

Page 79

Christopher Fry, UK, Westminster School of Art, Univ. of Westminster, **REGULATING OBSERVERS: VISUALITY AND THE INFLUENCE OF SCOPIC REGIMES ON THE EXPERIENCE OF VIRTUAL SPACE**, paper

Page 90

Curtis L Palmer, Canada, Edmonton, Alberta, **THE BLACK HOLE AT THE CENTRE OF THIS ORB IS A RHOMBIC DODECAHEDRON**, artwork

Page 94

Daniel Bisig, UK, Switzerland, , "Center for Dance Research, Coventry University, Coventry, United Kingdom; Institute for Computer Music and Sound Technology, Zurich University of the Arts, Zurich, Switzerland, **PRACTICAL RESOURCES FOR DEVELOPING IDIOSYNCRATIC GENERATIVE SYSTEMS FOR DANCE**, paper

Page 113

Davide Prete, Sergio Picozzi , USA, University of the District of Columbia, The Catholic University of America, **GENERATIVE DESIGN OF LATTICE STRUCTURES FOR 3D PRINTED SCULPTURES**, paper + artwork

Page 123

Dmitry L. Weise, Russia, Central Research Institute of Dental and Maxillofacial Surgery, Department of Radiation Diagnostics. Moscow, **PERIODIC STRUCTURES ON PHYLLOTACTIC PATTERNS**, paper

Page 131

Dota Alexiou, Dimitris Gourdoukis, Greece, School of Architecture, Aristotle University of Thessaloniki, **SIMMETRY AS REPETITION**, paper

Page 144

Dragana Ciric, Serbia, Independent Scholar/Scientist, PI, Founder and Architect / unit [d]., **GENERATIVE DESIGN PRINCIPLES AND ALGORITHMIC THINKING IN ARCHITECTURAL PLAN VARIATIONS: HUMAN TO MACHINE APPROACH** , paper

Page 157

Elisavet Parisi, Dimitris Gourdoukis, Greece, School of Architecture, Aristotle University of Thessaloniki, **XENAKIS AND THE OTHER BETWEEN DETERMINISM AND THE UNEXPECTED**, paper

Page 165

Enrica Colabella, Italy, Generative Art & Design Lab, Argenia, **FLOWING IN GA NATURALNESS**, paper

Page 175

Hans Dehlinger, Germany, Department of Product Design, Universität Kassel, **IMAGE FROM FIBONACCI GENERATIVE ART SERIES: FIB_D2_ROT-2016**, artwork

Page 177

Haruka Hirayama, Vasilis Agiomyrgianakis, Japan, Greece, Department of Information Media, Hokkaido Information University, Ebetsu, Japan - Department Audio & Visual Arts, Ionian University, Corfu, Greece, **ACTS FOR TELEMATIC PAINTING AND LIVE CODING**, paper + Performance

Page 183

Helena Verril, UK, Department of Mathematics, Warwick University, **GENERATIVE ART FROM THE CALCULUS CLASSROOM**, paper

Page 190

Jeff Morris, USA, School of Performance, Visualization, and Fine Arts, Texas A&M University, College Station, Texas, **SNAKE IN THE LABYRINTH**, paper + video music

Page 191

Leo Baldwin-Ramult, New Zealand, Elam School of Fine Arts, University of Auckland, **GENERATIVE COMPUTER ART AND THE UNCONSCIOUS**, paper

Page 200

Mahnaz Shah, UK, Edinburgh School of Architecture and Landscape Architecture, University of Edinburgh, **CITY OF MEMORIES – CITY OF VOIDS. GENERATIVE MECHANISMS WITHIN CONTEMPORARY GLASGOW CITY**, paper

Page 210

Mark Zanter, USA, Marshall University, School of Music, **THE USE OF MARKOV CHAINS IN EX MACHINA**, paper

Page 216

Michael Burt, Israel, Faculty of Architecture & Town Planning Technion I.I.T Haifa, **KALEIDOSCOPIES - KALEIDOSPACES ON A BUILDING SCALE AND THEIR INNER ORCHESTRATED SPATIAL CHOREOGRAPHY**, paper

Page 226

Monika Karwaszewska, Poland, Stanisław Moniuszko Academy of Music in Gdańsk, **TO SEE THE INVISIBLE. INPHRASTIC INSPIRATIONS BY NIGHT NATURE PHOTOGRAPHY. FROM PHOTOGRAPHY TO AUDIOVISUAL COMPOSITION**, paper

Page 234

Nathan Matteson, Nicholas Kersulis, USA, School of Design, College of Computing and Digital Media, DePaul University, Chicago IL; Otis College of Art and Design, Los Angeles CA, **GOOD-FOR-NOTHING (WORKING-CLASS ITALIAN GENTLEMAN #1) AND GOOD-FOR-NOTHING (WORKING-CLASS ITALIAN GENTLEMAN #2)**, paper

Page 236

Patryk Wasiak, Poland, Institute of History, Polish Academy of Sciences, Warsaw, **PRACTICES OF PROGRAMMING AMATEUR COMPUTER GRAPHICS IN THE 8-BIT MICROCOMPUTER ERA**, paper

Page 239

Philip Galanter, USA, School of Performance, Visualization & Fine Art, Texas A&M University, College Station, **MATERIAL GENERATIVE ART**, paper

Page 245

Robert Spahr, USA, School of Media Arts, Southern Illinois University Carbondale, **AESTHETIC MUSINGS: EVIL AS A GENERATIVE PROCESS**, paper

Page 248

Rongrong Zhou, China, Peking University, **CURATED NOVEL**, paper

Page 258

Silvija Ozola, Latvia, Riga Technical University, **THE MAGIC OF LIGHT IN THE URBAN ENVIRONMENT IN LATVIA**, paper

Page 274

Sławomir Wojtkiewicz, Poland, Białystok University of Technology, Faculty of Architecture, Department of Visual Arts, **THE CONSTRUCTION**, paper

Page 276

Tatsuo Unemi, Japan, Department of Info. Sys, Sci., Soka University, Hachioji, **INDIVIDUAL-BASED EPIDEMIC SIMULATOR AND ITS VISUALIZATION AS GENERATIVE ART**, paper

Page 281

Tristan Cazenave, Guillaume Grosjean, Baptiste Rozière, Anna Pappa, France, LAMSADE, Université Paris Dauphine – PSL, Paris - LIASD, Université Paris 8, Saint-Denis, **MOLIAIRE, A THEATRICAL AGENT WHICH SPEAKS LIKE MOLIÈRE'S CHARACTERS**, paper

Page 286

Umberto Roncoroni, Peru, Facultad de Diseño, Universidad Peruana de Ciencias Aplicadas, Lima, **PROGRAMMING COMPLEX 3D MESHES. A GENERATIVE APPROACH BASED ON SHAPE GRAMMARS**, paper

Page 295

Zi-Ying Liao, Sheng-Fen Chien, Taiwan, National Cheng Kung University, Tainan, **INK-SIGHT, MY SIGHT**, paper

LIVE PERFORMANCES

Page 306

Beata Oryl, Michał Garnowski, Poland, Stanisław Moniuszko Academy of Music in Gdańsk, **ALBION INTERMEDIA PROJECT**, performance

Page 308

Enrica Colabella, Celestino Soddu, Kathryn Ricketts, Italy, Generative Art & Design Lab, Argenia, Canada, University of Regina, **NATURALNESS GENERATIVE SILENCE**, performance

Page 310

Filippo Gregoretti, Daniela Bendoni, Italy, Dipartimento di Scienze della Comunicazione, Università Suor Orsola Beincasa, Napoli, **AD VITAM, EXPLETUS, AN AI POWERED AUDIO-VISUAL JOURNEY INTO IMPERMANENCE**, performance

Page 314

Guillaume Rochais, France, ACCRA, Université de Strasbourg, **SURFING THE AUDIO WAVE: A7, A CUSTOM GENERATIVE VJING SOFTWARE FOR VISUAL IMPROVISATION**, performance

Page 326

Jonatas Manzolli, Alexandre Zamith, Daniela Gatti, Mariana Baruco Andraus, Manuel Falleiros, Brazil, Department of Music, Institute of Arts, Int. Nucl. Sound Studies (NICS) UNICAMP, Campinas, **JARDIM DAS CARTAS: GENERATIVE AND INTERACTIVE INSTALLATION IN MIXED REALITY FOR MUSIC AND DANCE**, performance

Page 336

Kathryn Ricketts, Angela Ferraiolo, Arne Eigenfeldt, Canada, USA, University of Regina, Canada, Simon Fraser University, Canada, Sarah Lawrence Collage, USA, **BLOMSTER**, Performance + video installation

Page 338

labora media, Germany, labora media, **SALTATIO UNDA**, performance

Page 339

Philip Galanter, USA, School of Performance, Visualization & Fine Art, Texas A&M University, College Station, **SYMBIOTIC CHROMATICS**, artwork-performance

Page 339

Yan Bello Méndez, Spain, Creative Founder & AI Expert. SpaceMinds SL, Madrid, **AN AGILE - MULTIDISCIPLINARY APPROACH AND INNOVATIVE TOOLKIT TO CATALYSE GENERATIVE CREATIVITY AND CHANGE**, paper + artworks

OPENING XXV GENERATIVE ART CONFERENCE

Twenty-five years ago, a small group of scholars, creatives, and experts in Design and Art were together at the Polytechnic University of Milan for the first Generative Art conference. The experiences were different but all related to the possibility of managing, through computer and other technologies, the creative processes inherent not only in art but also in design, music, graphics, and architecture. This first meeting also sanctioned the use of the term "Generative Art" coined for this first conference. Its meaning defined not a specific technique or technology but a logical approach that involved all participants in their creative activity. In the 1960s, it would have been called a meta-design approach, but in 1998, when digital technology had passed its first steps even as a support for human creativity, the term generative became an explicit way of calling a creative work that, with the help of various and multiple computer and non-computer techniques, defined the prerequisites for working not for a single result but for defining a possible multiplicity of results, all unique but all in tune with the author's vision, which thus regained its own identity and recognizability. In parallel, there was a common vision of the possibility of mass-producing unique objects with available numerically controlled industrial technologies.

The participants to this first conference agreed to go ahead and define generative art as a newborn child that had to be respected and preserved from those who wanted to mystify it or accumulate it only to production techniques.

Indeed, it is no coincidence that those who, in the following years, attempted to appropriate the term Generative Art were people who were giving a definition of it as a possible technique and writing manuals about it. They did not find a place in our conference but, as of today, there is a need to revive the primitive definition of Generative Art and to work together so that Generative Art continues to indicate a logical interpretive approach capable of giving a boost to the creative approach and to the revaluation of the author and his recognizability.

25 anni fa un piccolo gruppo di studiosi, creativi ed esperti di Design ed Arte si sono ritrovati al Politecnico di Milano per il primo convegno Generative Art. Le esperienze erano diverse ma tutte riconducibili alla possibilità di gestire, attraverso le tecnologie informatiche e non, i processi creativi insiti non solo nell'arte ma anche nel design, nella musica, nella grafica e nell'architettura. Questo primo incontro sanciva anche l'uso del termine "Generative Art" coniato per questo primo convegno. Il suo significato non definiva una specifica tecnica o tecnologia ma un approccio logico che coinvolgeva tutti i partecipanti nella loro attività creativa. Negli anni 60 si sarebbe chiamato approccio meta-progettuale ma nel 1998, quando la tecnologia digitale aveva superato i primi passi anche come supporto alla creatività umana, il termine generativo diventava un modo esplicito di chiamare un lavoro creativo che, con l'aiuto di varie e molteplici tecniche informatiche e non, definiva i presupposti per operare non per un unico risultato ma per definire una molteplicità possibile di risultati, tutti unici ma tutti in sintonia con la visione dell'autore che così riacquistava una propria identità e riconoscibilità. In parallelo, si intravedeva la possibilità di realizzare in serie oggetti unici con le tecnologie industriali disponibili a

controllo numerico.

I partecipanti si sono trovati d'accordo ad andare avanti e a definire l'arte generativa come un bambino appena nato che doveva essere rispettato e preservato da chi lo avesse voluto mistificare o accumulare solo a tecniche realizzative.

Non è infatti un caso che chi, negli anni seguenti, ha tentato di appropriarsi del termine Generative Art siano state persone che ne davano una definizione come possibile tecnica e ne scrivevano sviluppando manuali. Nel nostro convegno non hanno trovato spazio ma, ad oggi, occorre rinverdire la primigenia definizione di Arte Generativa e lavorare uniti perché l'Arte Generativa continui ad indicare un approccio logico interpretativo capace di dare una spinta alla creatività umana ed alla rivalutazione dell'autore e della sua riconoscibilità.

Celestino Soddu and Enrica Colabella
Founders and Chairs of Generative Art Conferences



Francesco Borromini drawing

LIVE PERFORMANCES

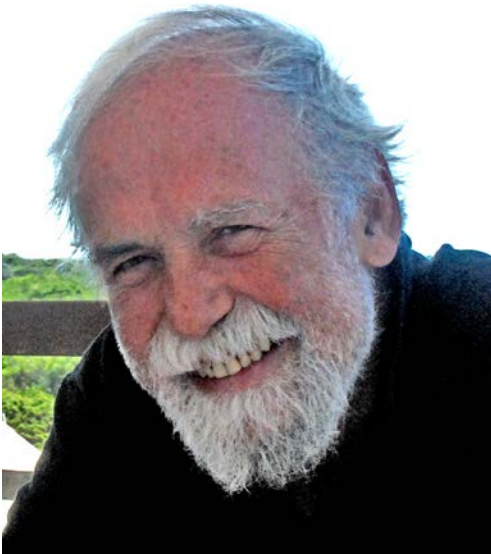
Generative Art & Design. Visionary Algorithms for a Natural Complexity

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Celestino Soddu

Premise

Generative Art, a field defined by a precise creative approach, has in the last two decades become synonymous with digital art. And this has been greatly augmented by the emergence of NFTs that presuppose the creation of digital events that are all different but identifiable in a recognizable collection. This is a definition that echoes that of Generative Art.

With this paper, I would like to clarify the identity of Generative Art not as a

technique but as a creative logic that cannot be associated with specific technologies.

GENERATIVE ART
NOT TECHNIQUE | BUT CREATIVE LOGIC

Generative Art can use a variety of tools, including non-digital tools, but it is strongly characterized by the creative logic of creating artificial species. In this paper, I would like to focus on the use of Artificial Intelligence, which is the tool I have developed in my creative history, and I would like to clarify the possible role of AI in the artistic approach.

Emerging issues in Generative Art are:

1. How to support creativity with AI.
2. How to succeed in being creative by managing complexity, understood as a Nature-like system.
3. How to generate results that have the character of uniqueness and complexity but that reflect the artistic approach, i.e., tell an idea, a recognizable vision that belongs to an author's identity.

Creativity and Artificial Intelligence

First, it should be clarified that AI cannot be creative by itself. Creativity can only belong to the person who wrote the software. The AI system can implement the author's creative ability, so it can be a tool that supports the author in his ability to create. Specifically, the ability to generate, in parallel, multiple and different events as are, in Nature, individuals of the same species.

HUMAN BEINGS

with AI:

- 1 - INCREASE CREATIVITY
- 2 - RESULTS → COLLECTION OF RESULTS
LIKE SPECIES IN NATURE

It needs to be clarified how, at the base, this is achieved, whether through randomness to generate forms or by building and structuring a possible vision that is intended to be achieved in the results. In the latter case, randomness is confined to creating an occasion to activate the author's vision.

It is indeed possible to use randomness in such a way as to have results that may even be surprising, but this should not be confused with creativity, which, as in the case of architecture, design, art, and music, involves imagining a system of events that are topologically connected in a way that fits the expression of one's poetics.

Randomness can be used only as an emulation of the unexpected

The random factor, then, can only be used when choosing between parallel processes already structured as possible alternatives, each of which still represents a facet of one's poetics.

Technically, the random-based process and the creative process may seem

similar even in possible outcomes. But while the former does not express poetics, the latter does, and it is, precisely because of this identity each result is strongly recognizable as an artistic expression of an author.

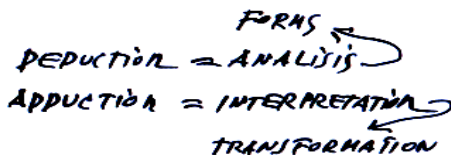
RANDOM → SURPRISING
CREATIVITY → POETIC

In the case of the use of AI, where does the subjectivity of the author and thus the ability to produce creative and recognizable events intervene? Certainly not only in the basic AI system but also and especially in the database that is used to build, in progress, the identity of the system, its singularity.

In the case of my Argenia software, this database is not a collection of data but of algorithms. Moreover, this collection is always growing and is essentially composed of "memories" arising from years of creative design work. These memories are not forms used in previous projects but geometric logics of progressive transformations used to generate multiple forms, always different but strongly characterized by my recognizable poetics.

In Argenia, therefore, the database of singularity is formed by a collection of strongly characterized geometric transformations: geometric algorithms, which constitute a universe of options, among themselves different and sometimes conflicting. These algorithms represent my design history and creative identity. They are visionary algorithms. They do not define a form but how a possible geometric input could be transformed. It may be used at any point in the creative process. It is transformed to increase its specific character. It performs the responsiveness to the idea not yet made explicit in a final form.

Whenever I start a new project, I often add some new algorithmic event to the previous transformation logic. Adding it does not mean using it directly but inserting it into the sea of already existing and operational options. This insertion enables it to be used in the progressive logic adopted by Argenia. Argenia's logic is based on the framework of geometric transformation algorithms themselves, visionary algorithms, which have an additional option over shapes. While the forms are alternatives one to the other, the transformations can act in succession, layered in parallel, and contaminated with existing or forthcoming transformation logic.



Thus it is always possible to reach a further level of complexity that increases the recognizability of the results. It is possible to verify this if we read the difference in the level of complexity between the first generative projects I developed in the 1980s and the current ones.

Complexity and the reference to Nature.

Complexity is one of the goals that I have set for myself from the beginning and that has Nature as its main reference, but also the complexity in progress of some "historical" cities that, while maintaining their specificity and recognizability, have increased over time, managing to transform each new event into a further

representation of their identity.

Generative Art tends to achieve a complexity of a natural kind. So it happens in Nature where external events, even traumatic ones, collaborate to increase species and individual recognizability. The clearest example is the olive tree, which the more it is scrambled by the wind, the more it acquires the recognizable appearance of an olive tree, increasing, in addition, its recognizability and individual uniqueness. The complexity achievable through the generative approach does not tend to reduce the recognizability of the idea but tends to strengthen it. This is the role of the AI generative system.

Wind and forms are random and unexpected. The random parameter to simulate environmental unpredictability can be, as in Argenia, a progressive parameter number representing time. And it is, like time, always different.

Argenia's ambition is to emulate Nature. The fundamental contribution is made by a parameter representing time, as is also the case in historic cities. Indeed, it is not possible to represent a historic city by design except through a path of temporal growth. The experiments of Piranesi, who layered successive creative actions in the same plates over time, are very instructive in this. The search for (natural) complexity can only happen through time and the operational memorization of the transformation logic adopted in the past. In my case, the visionary algorithms reflect more than fifty years of generative design work, which began already as a student during the last works developed at the Faculty of Architecture in Rome in the 1960s..

The Idea of Species and the Topological Paradigm.

Emulating natural complexity in the creation of artificial events has always been one of my design goals. The most difficult aspect has been to imagine this complexity as an open category (it can't be otherwise) that embraces all possible events that match the character sought. It means defining a process that can generate them all within the boundary of recognizability of the character sought, the recognizability of my poetics. In other words inside the recognizability of an evolving species, as in Nature.

The imagining of these categories, not yet associated with a form, is the starting point of Generative Art. The way I chose was to describe the idea of a species and its possible evolutions by identifying an open, fractalized structure, a paradigm that traced in progress its topological characters. A dynamic paradigm that would define the rules of its possible evolutions while maintaining the distinctive characteristics of the idea.

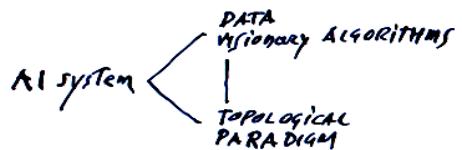
The rules of this idea-paradigm, then, define only the vision of the possible traced through the relations between the parts and not their respective possible forms. The theoretical and operational reference is the essential structure of creativity as defined by Poincaré: to create is to define visions of new possible relations between existing events, without entering into the merits of their respective forms. The concept of interchangeability of forms within the same idea and its recognizability enters strongly into the logical structure of my generative approach.

The dynamic structure of this topological paradigm is similar to a logical fractal. Indeed, it is about maintaining the recognizability of the idea from the total down to the details that have not yet been outlined. My idea for architecture has always been to use the same

creative logic from the door handles down to the overall volume arrangement. For example, going into a building the identity might be being able to know the location of the stairs from the door configuration.

The components of a generative project

We thus come to identify the three components of a generative project as Argenia: the AI engine, the database of visionary transformation algorithms that represent the singularity of the generative process, and the starting idea of each generative project realized through a topological and dynamic paradigm.



The latter, which can also arise from the topological interpretation of an existing event, including a natural one, is the human contribution to each generative process, is the creative idea, and cannot be realized by the machine.

Given the human aspect of the formulation of the idea and the in-progress construction of the logic of transformation, one would think that the AI body would be greatly reduced in both size and function. Nothing could be more false. The structure of AI is the result of a dynamic representation of the design process realized through its compositional logic. This structure is a highly subjective system that is capable of navigating the labyrinth of transformational logic, of visionary algorithms that tell a way of seeing the

possible. The system is configured as a topological ship, a highly discontinuous and nonlinear system that maintains the direction of the recognizability of the poetic matrix despite the possible and unpredictable layering of events.

Each navigation is always an exciting adventure leading to surprising results but all are characterized by the recognizability of species, thus the recognizability of the author's vision.

Above all, year after year, the use of this AI structure leads to results whose complexity turns out to be more and more natural, as are the events that have lived through time and now while being current, preserve the traces of their history.

Transformations and Forms, Copying and Interpretation, Deduction and Adduction.

The power of transformation and topological logic over the direct reference to forms has undoubted advantages. For example, it is not possible to "copy" a design but only to interpret it. The act of interpretation occurs precisely when a reference is taken into consideration and a possible logical transformation is adduced that can generate the required character. This is an operation that is never deductive, and in fact cannot be because within the interpretive process the nodal element is the discontinuity, the logical jump between the topological arrangement of the reference and its interpretation.

Even the evolution of a project is the result of the progressive interpretation of the topological paradigm and the endogenous processes of discontinuity in the system. This is made possible by the fact that transformation logics are, by

nature, freely associative generating results that are nonlinear but capable of representing one of the facets of one's vision.

The 3-D scenarios generated by Argenia in recent years have so increased the processes of contamination of progressive transformation logics that, unlike the first generative experiments of the 1980s, the resulting complexity is not at all decipherable through analytical readings operated a posteriori on the generated model but is only assessable in terms of identity and recognizability achieved.

The complexity of these scenarios is thus decipherable as "artificial naturalness," and this was my goal from the beginning of this work..

The functional aspects and the multiplicity of possible design themes

The basic AI system in Argenia is thus not creative by itself. This system operates by systematizing the possible use of logical transformations as they are progressively created and structured in a database of visionary algorithms suited to progressively increase the singularity and uniqueness of the results.

The "functions" that are identified for each logical transformation are abstract functions: how it ends, how it folds, how to divide, etc., and are not related to specific shapes or dimensions but only to the relationship between the various elements considered. The symbolic function is naturally made explicit by the topological relationship with other events, and the aesthetic function is due to the progressive contamination and layering of the transformations made, each of which carries with it the underlying

poetics.

With Argenia it is possible to generate very different events, from architecture to cities, from objects such as chairs to three-dimensional portraits, from fantastic animals to jewelry, artificial flowers, etc. This is due, fundamentally, to the idea that is made explicit in a topological paradigm that abstractly tells the symbolic structure of the event that can then be filled with functional connotations. But also by the construction of geometric transformation logic created following specific visions. The surprising and exciting fact is that these transformation logics do not remain confined to the generation of the same specific object, in the specific function that was the occasion of their creation. These logics expand using the specifics of Argenia's structure and are used, often in contamination with existing others, to generate events at another scale and with different functions. This is possible because of the formal neutrality of the logic included in the singularity creation database. For this reason, I like to identify them as visionary.

Conclusion

In conclusion, Argenia is not a creative software but enhances the creativity of its user. Subjective creativity is explicit not only in the design logic adopted to create the AI system but especially in the initial topological paradigm that characterizes each generative project and in the progressive increase of data algorithms of visionary transformations that build the singularity of the system over time.

Argenia, focusing on my generative approach, is the active and progressive memory of my design creativity, capable of generating new and unpredictable variations of each of my design ideas

stored with a topological paradigm open to the possible.

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principles of destruction (emergence)

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The glacier has been most important for me....it conveys the principles of cold and warm, energy and process - Joseph Beuys

Drone Beuys, the collaborative collective led by Adam Fung and Nick Bontrager, works with experimentations with drones, video, animation, sculptural forms. Our projects are created from sources derived of field

expeditions, studies, and research ranging from west Texas to Iceland to the Tuscany. We are interested in physical state changes, as suggested by the Beuys quote above and the dichotomy of extraction and renewal.

Using data and imagery directly observed-the collaboration with the landscape shifts to the studios of Fung and Bontrager as they respond to contemporary issues and technologies. This new video work falls under the working title of *principles of destruction (emergence)* and is the first rendition of what will be a generative work, the link provided at the end of this document is an work in progress example of what will be a longer four minute video piece.



Parsing the complexity of contemporary relationships with the natural world and the possibilities of the technologies driving extraction of natural resources from the planet, we seek to portray a world-sized arena that is immersive in scale. Ideally exhibited via projection, to mesh our imagery with a site, but future editions of *principles of destruction* will utilize a large video projection paired with sculptural forms that echo animations in the video. The synthesis of these forms with the video projection will be visual but equally united by a sonic component. While ominous sounding, *principles of destruction* aims to challenge the current status quo of human extraction of landscapes and natural resources.

Forms situated digitally in the video evoke loss and deterioration

but also opportunities for regrowth and renewal. These forms are juxtaposed amongst aerial footage, sound recordings from research expeditions, 3-D renderings arising from landscapes visited by Fung and Bontrager. Evoking a plethora of Anthropocene era ecological disasters, this new work by Drone Beuys presents a myriad of scenarios to counter what is often a bleak prognosis, forms shifting and collapsing within themselves (and into each other)- in a tectonic arena positing a narrative of the principles of destruction but also hope for an alchemy of future technology, shifting principles, and an encounter with a sublime space. Ultimately, we see principles of destruction as a manifesto for paradigm shifts that are necessary in our contemporary cultures. We believe art can be an avenue to plant the seeds of change-opening up new ideas and conversation

The Algorithm of generating alternative models from the heritage Houses' Gates in old Mosul city

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Abstract

Old Mosul city is rich in architectural details and style and is considered one of the multi-culture cities. Each culture added its details to the original architectural style. Traditional houses in old Mosul city are known for the solid facades, which include a few architectural elements, such as gates and windows. Therefore, traditional houses are known by their gate details, which are varied in materials and formation system. The study conducted to deal with the deformation problems during the renovation and reconstruction of the heritage houses, especially in the details of the gates because of technology effects and migration of labour professionals and craftsmen. The study aims to determine the algorithmic process of generating new alternative models of Mosulian gates that can be used in new buildings or in the renovation process. Geometric analysis

and artificial intelligent methodology are used to analyse the original samples and regenerate new models artificially depending on the results of the analysis. The results show that the effects of materials and colours have a limited impact on the matching with the original, while the formation system is the main element of generating and matching with the original.

1. Introduction

The Old Mosul City is one of the heritage sites that faced war disaster and unplanned reconstruction and renovating process. Going through the allies of the city is a discovery process of the heritage architectural buildings and their elements (Thannon, 2007). The Mosulian allies included few façades element, such as openings details, which characterized by the variety in the details and unity in the syntax of these elements (UNESCO, 2022). The research problem observed by the impressive deformation of the reconstructed houses by the owners and some national and international organizations, whos assist the owners to rebuild their houses to reuse them as residential or other functions after the distortion of the war in 2017. The study focuses on the gates' design of

traditional houses (figure 1), which considered the important facades element.



Figure 1. Samples of traditional gates details. (source: captured by researchers).

Few studies conducted to analysis and discussed the architectural elements of traditional facades in old Mosul city. Old Mosul city located in the north of Iraq, which is the biggest and main city in Nineveh Governorate. The literatures highlighted the important types of Gates design that included in the famous traditional houses in old Mosul city, such as the house of 'Amin Bak Al-jalily', 'Mostafa Al-Tutunchi', 'Numan Al-Dabagh', 'Hamu Al-Qado', 'Ziadah', and 'Abdoni', which included various gates design. Mahmood (2015) mentioned that 'Amin Bak Al-jalily' gate are 2.6m x 2.3m opening size with pointy vault by 4 centers bounded by vertical and horizontal ornaments using traditional stone material, while the second gate is totally destroyed and closed by new construction materials. The using of new materials and designs affected the originality and heritage value. Therefore, reconstructed gates should follow the main elements of the gate, which are three elements (vertical elements, horizontal elements, and vault). Moreover, the ornaments should follow

the original style and used in the same elements of the gate (Mahmood, 2015).

Entrance is the important functional element in the traditional houses located on the middle or side of the house wall faced the allay(Qadir, 2020). The entrance consists of three parts. The first part is the walk way to the house, which planed in (S) or (L) shape for privacy factor. The second elements is the frame of the entrance, which considered the gate of the house because the including of the vertical and hor izontal elements, which usually made of Mosulian marble by hand (Al-Maadhedi, 2002). The vertical elements are work as columns designed by two or three parts decorated by geometric or floral elements (Mahmood & Alchalabi, 2022). The horizontal part work as beam, which designed as arches or vault with various types. The last part of the entrance is the door, which usually made of wooden material with simple ornaments. Most of the gates contained an extra elements over the vault or arches, which decorated by complex ornament linked to the vaults and arches (Mahmood, 2015).

Ismaeel (2014) classified the entrances according to the details and elements. The gates of traditional house in Mosul included (8) parts as shown in (figure 2). This classification identified (2) groups of gates according to the richness of the gate with details and ornaments. The first group are simple design of the frame with simple ornaments (figure 3). The second group are the improvement of the first group by adding more details and frames around the gates, which usually used in the houses of the rich owners (Ismaeel, 2014)

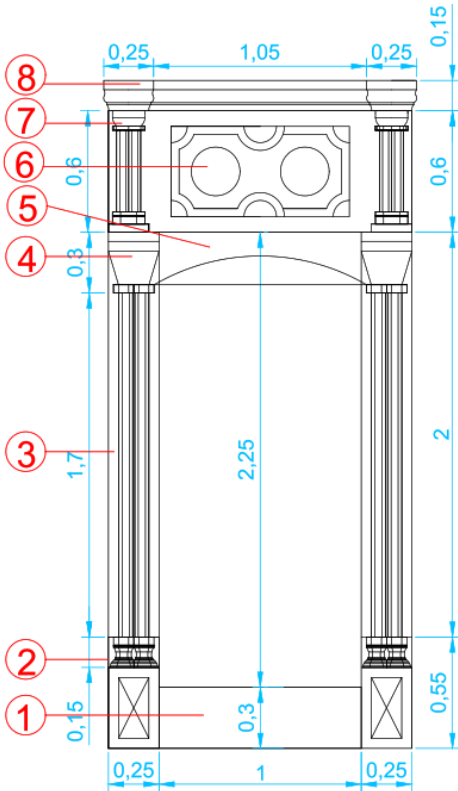


Figure 2. Sample of traditional gate showing the (8) elements identified by Ismaeel (2014)

- 1- Entrance steps
 - 2- Column base
 - 3- Shaft
 - 4- Capital
 - 5- Arches or beam
 - 6- Ornaments above the gate
 - 7- Additional ornaments & elements round the gate
 - 8- The frieze and Cornice
- (Source: adopted by the researchers from (Abdullah, 2021).

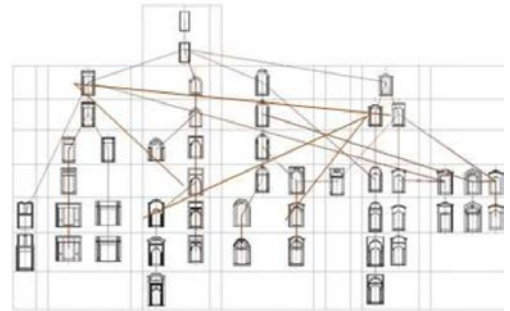


Figure 3. the two groups of gates formation (Ismaeel, 2014,p78).

The design of the traditional gates follows the principles of reflection on the vertical axis of the gate, which provided perfect symmetrical overall shape. The elements of the gates included additional principles according to the gate style, which are mostly reputation, reflection, hierarchy, proportion, scale, and transformation (Ismaeel, 2014; Mahmood, 2015; Mahmood & Alchalabi, 2022).

2. Methodology

The study applied the qualitative and experimental approach using visual analysis and observation to discover the main rule of generating the gate form. Check list observation sheet design to collect the data by observing the formation system (table 1). Generating new models from the original elements and shape relation by applying the rule of formative system with modifying the elements and exchange some with others from another gate.

The visual analysis included two steps. The first level categories the gates with in groups depending on the classification provided by literature (Ismaeel, 2014). The second step is analysis the formative system in two levels. The first level related to overall gate form. The second

level related to the formative system of the gate elements.

Table 1. Analysis checklist to discover the elements and principles of formative system.

Sample No.	Image	
Group type	Simple	Complicated
Elements	type	
Steps		
Column base		
Shaft		
Capital		
Arches		
ornaments		
Additional elements		
frieze & Cornice		
Principles	overall	element
Reflection		
Transformation		
Repetition		
symmetry		
Hierarchy		
Scaling		
Proportion		
Shape relations	overall	element
Tangency		
Overlap		
Adjacency		
Physical characteristics of overall form		
Width		
Height		
depth		

(source: The Authors)

In the current study, the color, material, and focus variables were neutralized on the formative system. Therefore, algorithmic steps of generating models from the original gates used in programming auto generating software with variables determined from the results of visual analysis. Auto lisp language within AutoCAD software to produce alternative models from the original gates in 2D drawing. The 3D

modeling will follow the physical characteristics of the gate details using extrude command after selecting the proper models produced from Auto lisp application.

3. Results and Discussion

The visual analysis results show the important of three elements of the gate as a minimum element can be used to format a gate, which are column shaft, beam or arch, and additional elements over the beam (figure 4).

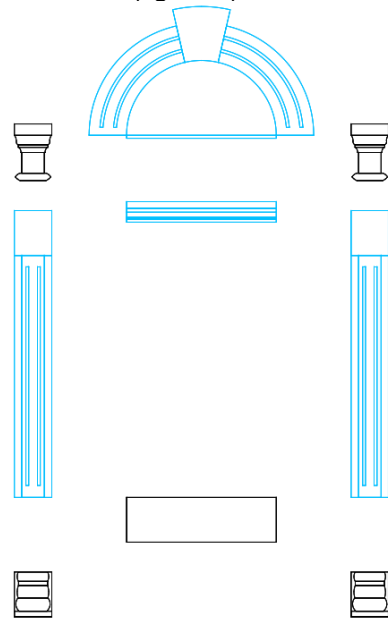


Figure 4. Sample No. 3 the 8 gate elements and the main 3 elements to generate alternative models (Source: The researchers).

The main three elements of the gate are used for framing the entrance, therefore these three elements are the basic elements to generate new designs related to the gates of traditional houses in old Mosul city.

The physical characteristic of the gate follows the proportion of 1D + (between

2.5D to 3D) x 2D with 0.5D as shown in (figure 5). This proportion reflect the size of the gate in addition to create a focal point in the alley wall of the house, which is type of emphasis the owner within the social class in the city.

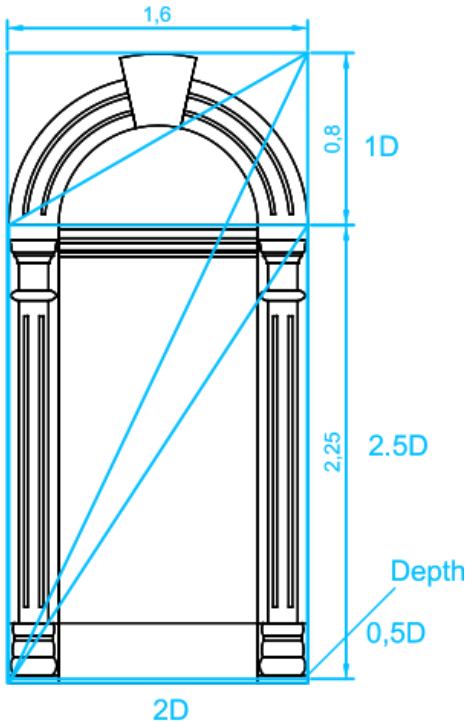


Figure 5. The physical characteristics of overall gate form for Smaple No.3 (Source: the researchers).

The results of the principles and relationship matched to the finding of the literatures, which confirms the importance of balance using reflection and perfect symmetry in overall and elements levels. Most of the ornaments in the gates are existed in the shaft of the column, which are mostly geometrical type. While the floral ornaments are existed in the additional elements over the cornice rounded by arch or frame with geometric ornaments.

The relationships between the gate elements are adjacency with 1D space

between the symmetrical columns, base, and capital. While the relationships between the elements of column and beam and additional elements are tangency relations as shown in (figure 6)

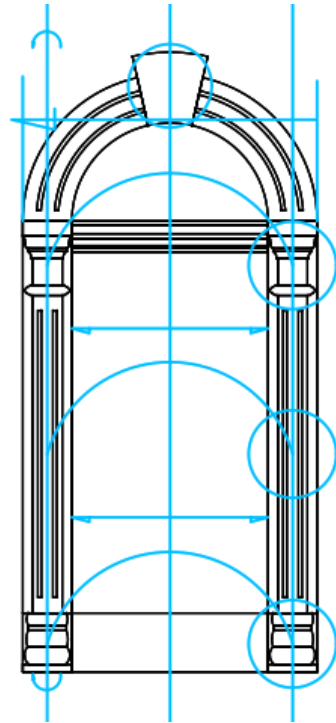


Figure 6. The axis of the balance and relationships between the gate elements (Source: The researchers).

The algorithmic process of generating alternative models of gates derived from original gates transferred to rules used in designing Auto lisp programing, which includes three main steps:

- Selecting the proportion of the gate.
- Selecting the number of elements included in the gate.
- Selecting three different gates that the designer plan to produce alternative models from them (figure 7).
- Selecting the rule and pr inciples for overall and elements level.
- Selecting the number of alternative models (figure 8).

- Selecting one alternative model to transform it to 3D models (figure 9). The steps appear in the comment par in AutoCAD software or as windows using visual C+ depending on the programming language used to apply the algorithmic.

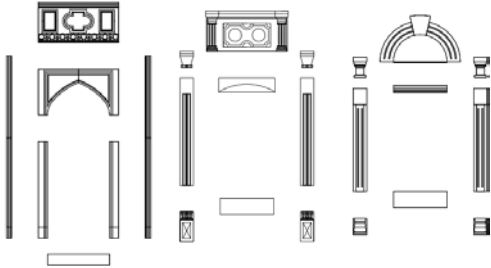


Figure 7. The step of selecting elements from three different gates (Source: The Researchers).

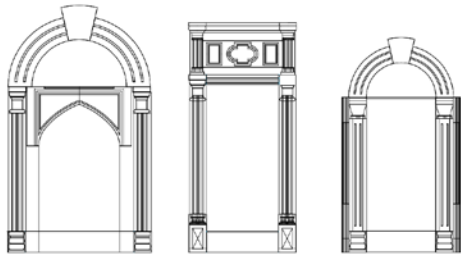


Figure 8. New models derived from three different gates with modifying in proportion and scale of overall and some elements (Source: The Researchers).

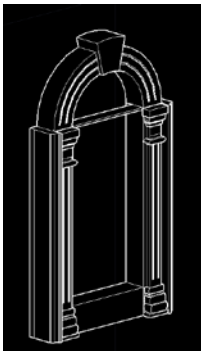


Figure 9. 3D model produced by using elements, rules, and relationships from original gates of traditional houses in old Mosul city (Source: The Researchers).

The final results of the producing alternative models show the semi-

matching with original gates although the changing and exchanging in the elements, rules, and relationships. However, some models matched with rate 50% with original gates, which reflect the non-harmonized elements with unusual proportion.

4. Conclusions

The gate is the part of the entrance of traditional houses in old Mosul city, which is considered an effective element on the façade formation. The formative system of these gates follows the principles and characteristics of traditional architecture in old Mosul city, which is originally a mixture of various architectural styles. The formation system included two levels (overall – elements). Each level included a set of rules to generate it by balance, symmetry, and repetition, especially for elements level. Seven steps are the algorithmic process of generating alternative models of the gate. Each step of formations depends of the selected elements, rules, and relationships, which designer is free to select from the data set that provided previously by a documentation of original gates.

Using programming language to produce an impact alternative models is not related to the language itself, but related to data set that provided by the researchers or designers to feed the software.

5. Acknowledgment

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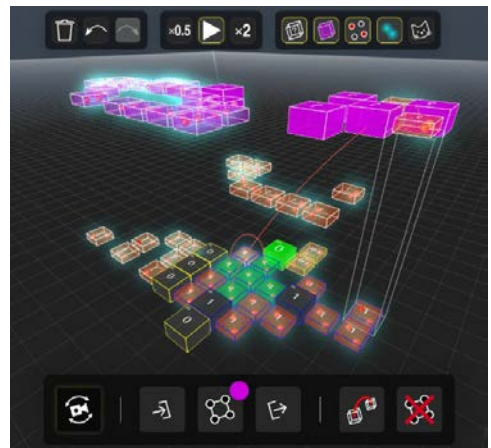
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Quantum Beings

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Abstract

We propose to use quantum circuits to generate atomic scale simulations of Quantum Beings. For this purpose we have developed an adapted version of quantum cellular automata, which work with qubits and quantum gates that allow to explore the possibilities of state superposition, entanglement, teleportation of information, etc.

The creation of Quantum Beings is here structural, and their viability is measured at the output of the circuits, giving us results (dead or alive) echoing the well known Schrödinger's Cat experiment.

Fig. 1. A Quantum Being
(Alain Lioret, 2022)

1 Quantum Beings exploring a new field for Generative Artistic Animats

Since their first mention by Stewart Wilson in 1985, animats have experienced a considerable growth and a large amount of work has been done around this concept. We do not pretend here to propose new algorithms around animats, but rather to introduce them in the emerging field of quantum computing.

The particularities of this new computing are numerous (see below). One can legitimately ask the question: in what way can quantum computing allow new perspectives for the development of future beings ? While some authors are starting to explore Quantum Artificial Life but also Quantum Biomimetism, we can no longer ignore the potentialities of quantum computing.

This article aims at opening a new door on a still unexplored domain. We don't have enough time to see where it will lead us. But we bet that the advances in prospective will lead us further than we can imagine with our current knowledge.

2 Quantum computing since Richard Feynman's idea

Since the discovery of quantum physics at the beginning of the twentieth century, many technologies have been developed and some are in the process of revolution. This is notably the case of quantum computing, which was introduced by the Nobel Prize winner Richard Feynman (19) about forty years ago.

Since the arrival of classical computing, many algorithms have been developed, and the recent advances in

Machine Learning have allowed very big advances in many computing fields.

However, the advent of quantum computing goes much further. First of all, it uses qubits instead of the classical bits of our good old computers. We thus go from a basic element with two possible values to a new element (the qubit) which can theoretically manage an infinite number of values, stored in the space of a sphere (called Bloch Sphere).

The new major ingredients of this new computer science are the superposition of states (being able to be worth 0 and 1 at the same time), the entanglement of qubits (instantaneous link between two qubits whatever the distance that separates them), and by direct consequence the teleportation of data (also instantaneous).

Since 40 years, this new computing is no longer a simple utopia: quantum computers have appeared and become more and more powerful. They already allow to obtain absolutely incredible performances (to produce calculations in a few minutes which would currently take... millions of years on the best current computer).

But beyond these astronomical performances, it is also a new way of thinking that emerges, and it is in this that we are interested here.

When humans invented the computer, they moved away from nature: basing calculations on lamps and therefore binary machines sent us on methods far from animal and human functioning. This is why it took so many years to come back to biomimetic methods and try to reproduce human or animal behaviors.

The arrival of quantum computing which works on the basis of particles (photons, ions, electrons, etc.) finally brings us closer to the creation and the natural order of the universe. Let's bet that this will bring us much further than we think today.

Therefore, the main idea of this article is to generate Artistic Beings using quantum computing, in order to explore what may appear possible.

3 Quantum cellular automata

The applications of quantum artificial intelligence are already very numerous and a new field of research: Quantum Machine Learning (QML) has appeared (7).

Of course, Artificial Life algorithms are not left out. And the first attempts in this direction were made around the creation of quantum cellular automata (8). These are based on

how to use quantum annealing to compute the deterministic game of life using a less direct encoding.

Several works have been carried out around cellular automata, first proposed by John Conway in 1970. Cellular behaviors that use quantum principles (superposition of states, entanglement) give very interesting results that open new exploratory possibilities. For example, the QCA application, developed by Lioret & al, allows to test the use of such automata in an interactive way.

This QCA tool simulates Quantum Cellular Automata Circuits and supports three-dimensional (3D) circuits and quantum entanglement, includes a tutorial, demos and missions to learn Quantum Cellular Automata, works on computers, tablets and cell phones and gives a playful visualization of the famous Schrödinger cats.

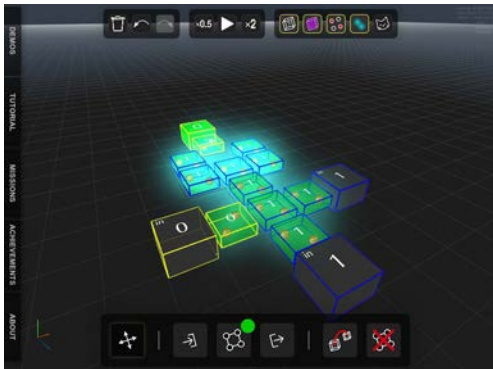


Fig. 2. Quantum Cellular Automata
(Alain Lioret, 2022)

4 Quantum Artificial Life

To go further, new attempts are being made to generate Quantum Artificial Life, which seems to us very relevant. We can quote the excellent work of Alvarez-Rodriguez who with his colleagues is one of the first to use quantum computers (those proposed by IBM) to try to create Artificial Life. [4][5]

Alvarez-Rodriguez present the first experimental realization of a quantum artificial life algorithm in a quantum computer. The quantum biomimetic protocol encodes tailored quantum behaviors belonging to living systems, namely, self-replication, mutation, interaction between individuals, and death, into the cloud quantum computer IBM.

“Thereafter, these and other models of quantum artificial life, for which no classical device may predict its

quantum supremacy evolution, can be further explored in novel generations of quantum computers. Quantum biomimetics, quantum machine learning, and quantum artificial intelligence will move forward hand in hand through more elaborate levels of quantum complexity”.

5 Towards a Quantum Being

Our goal here is to try to put in place the elementary bricks to generate quantum beings. Many tracks are available to us, especially those based on quantum cloning [10].

One of the works that inspired this article is the one proposed by Grand-Pierre [3]. This one is based on the little known work of Ervin Bauer who proposes a very original biological theory of life. [15][16]. This theory combines perfectly well with quantum principles and gives us innovative and exciting points of study.

We take up here our QCA tool in order to experiment the implementation of Quantum Beings put into action in the form of quantum circuits. The principle is simple: the quantum circuits will be used here to generate logical micro-organisms, which will behave according to the use of various quantum gates.

We make here a parallel with the first living organisms, appeared on Earth (multicellular beings with a DNA). Here the DNA of our virtual Quantum Beings is composed of quantum gate networks.

While many researches currently tend to give explanations to consciousness thanks to quantum physics (beyond matter), this approach seems to us relevant: indeed, as long as the result of the quantum circuit is not measured, the qubits which constitute it are in undetermined quantum states. This allows us to simulate the states of consciousness of our Quantum Beings.

The measurement of the quantum circuits makes it possible to fix a state of the Quantum Beings thus produced: they thus have a simulated structure whose results depend on the measurement of the qubits. This approach is still very experimental. However, it has the merit of adding a layer of structure that can be added to Quantum Beings created by more classical methods.

It is the measurement of these quantum structures that allows us to have this or that kind of Quantum Beings. Far from us the idea to introduce a mystical notion in the creation of our experimental Quantum Beings, but to use the quantum capacities which seem to be able to create very

strong variations at the time of the creation (by measuring the values of states vectors in the Hilbert space (Bloch Sphere)).

The combination of these values of state vectors in the Bloch Sphere is thus used to adjust the parameters of the generated Quantum Beings, which can be created in a very interesting way as strange creatures with no less singular behavior.

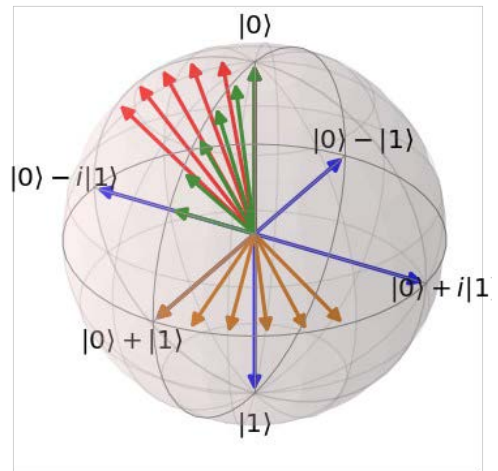


Fig. 3 : Multiple statevectors in a Bloch Sphere.

This is a generative production of Quantum Beings models, whose structure is in some way composed of a simulation of atoms, which are themselves structured in a quantum circuit. This experimental work is an exploratory research draft which aims at using quantum circuits for simulation.

Our work now consists in exploring the artistic possibilities offered by these new structures, by considering the creation of Quantum Beings from the smallest possible atomic level. In this, the use of qubits is a very good way to open this new research field.

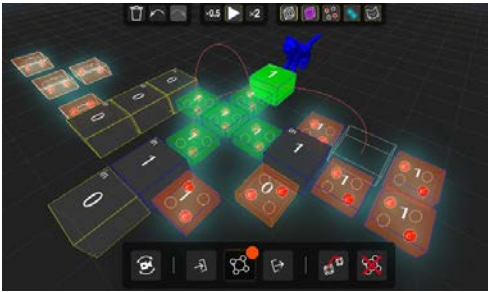


Fig 4 : A living Quantum Being

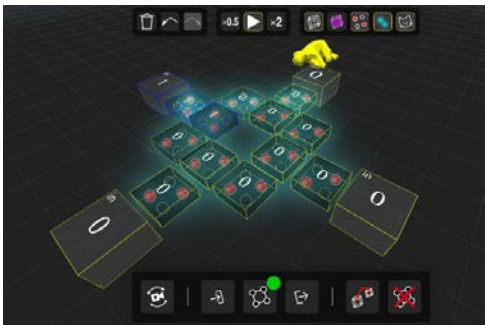


Fig 5 : A dead Quantum Being

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The generating process of alternatives of contemporary facades forms for Houses

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Abstract

The architects follow the trend of the architectural style used to design the facades of the buildings. The similarity in the design principles and elements in the designing of the facades are the most common problems in the contemporary era because of the difficulties that architects faced to add their creativity to the design without matching with the other architects to represent the speciality of the designer. The study was conducted to figure out the mechanism of generating new models of the facades' form related to selected designers, which can provide alternative models from the basic façade. The facades of contemporary houses are the focus of

the study. the methodology applied visual analysis of the selected façade sample to identify the principles, relationship, elements, mass and void, and colour. The results of analysis used to create a data set for artificial intelligence applications to generate new models of facades. The facades frame (width – length), depth, floors number, and the offside of the façade are the main variable to generate the new models artificially. The results identified the algorithmic process of generating new models linked to original design depending on the principles (symmetry, balance, transformation), the colour results show that in the contemporary design three colours usually used in the design in the ratio of (3-3-1), which one colour is in contrast with others. The ratio of mass to void is (3-1). The vertical and horizontal lines are used in the balance ratio.

1. Introduction

In the current era, designers faced various requirements related to the functions, styles, context, and trends of the design market, in which the client has a role in affecting the design, especially the design of the façade in the contemporary era. The trend of architectural style is rapidly updated following the international trend and the desire for improvement and change. Moreover, the emergence of construction and finishing materials enforced the designers to update their design trend, which was obviously reflected in the façade formation system. Various studies highlighted the problem of negative similarity and visual deformation of the urban image because of the fluctuation of the trend (Abdullrazaq & Abbas, 2008).

The improvement in design thinking is reflected in the formation of the façade, especially after using the technology in the design process and new construction materials and methods, which enhance the ability to implement any design to be existed. Ali (2009) highlighted that the problem of the improvement and variety of the formation system of the façade in Baghdad referred to the unclear effects of the formation system of the façade (Ali, 2009). Therefore, in one street, three or more of houses' façades are included similarity for more than 70%, which may belong to the same designers of the construction company (figure 1).

The problem statements of the current study determined after the pilot study done by observing the houses façade in

the three different quarter in the Nineveh Governorate to highlight the main problems that enhanced the similarity issue.



Figure 1. Various façade form design by different designers in Nineveh (Source: architect Ashraf Alhafody, Architect Amer Azawi)

The aim of the study is to figure out the mechanism of generating new models of the facades' form related to selected designers, which can provide alternative models from the basic façade. The mechanism is to assist the designer to generate models of the façade form depending on the designer style and trend to reflect the speciality of the designer on the facades design.

The similarity in the faced form link with the form characteristics, elements, relationship, and material, which affect the exterior of the buildings. The façade elements are mostly common between the buildings, but the differences in the manage the relationships and location in the façade. Opening elements is normally framed or designed with walls of

the facades. Moreover, columns, masses, vertical and horizontal elements such as open roof or balcony are the main elements of the facades (Wadah, 2005). The principles of design have a role in the similarity and creating trend for the designer, which harmony, contrast, unity, balance, and axiality are mostly used in the designing process in the contemporary era (Abdulqader et al., 2015).

Amer and Gaber (2018) discussed that the visual deformation in the city related to the multi-themes of the facades design related in the same period. The design of the façades should follow the trend and the style or context of the street and any modification or adding strange elements or materials (Amer & Gaber, 2018). However, facades formation depends on the structure of the form of the buildings. Moreover, the additional envelop covered the original façade of the building has a role in the similarity in addition to the new construction material (Çıkiş, 2007). Architects responded to the environmental requirements by adding elements and principles of design to the facades to achieve the comfortability of the users (Pastore & Andersen, 2022), which is another affected factor in the formation of the façade.

The form, space, and order in the designing of the architectural facades was highlighted by Ching (2014), which identified the principles, relationship, and finishing of the buildings to create better architecture. The balance, harmony, and scale are most used and effective principles that can be used to create a suitable façade for suitable functions (Ching, 2014). The vertical, horizontal, and surfaces are the main physical

facades elements. Moreover, pure and irregular shapes can be included in the design process of the facades to create levels and extended of the buildings. While mass and space, solid and void are also physical elements of the façade created by the another physical element (Gunce et al., 2019).

In conclusion, the similarity in the design of the facades can be in positive or negative impact on the buildings and image of the city. Trend of façade design depends on physical elements, principles, and relationships, which the specialty of the architect can emphasize due the way of dealing with these three factors. Moreover, the colours and materials relations have a role in the matching process of the facades formation.

2. Research Methodology

The research methodology applied formal analysis method to random selected samples of houses facades. The visual analysis method is widely applied in architectural studies (Gunce et al., 2019), which can be applied using Auto analysis programming or manually by the researchers and the two way are depend on the data set that should be provided. Therefore, visual observation using checklist sheet used to record the analysis of selected cases (table 1).

The variables and values arranged in the checklist (table 1) contained four parts. The first part is general information about the selected sample. The second part related to the main shapes that used in the forming the facades, while the third part is to observe the relationships and

design principles applied in the selected sample. The last part is related to the materials and colours and the way of applying them in the façade. The analysis of the sample is to the façade wall and excluding the fences.

Table 1. The variables and values as a checklist form.

1 Sample Information				
Sample image		code		
Designer		Construction year		
Area of Facade		Number of facades		
2 Shapes and elements				
Vertical				
Horizontal				
Pure shape				
Irregular shape				
Surfaces				
Columns				
Mass ratio				
Void ratio				
3 Principle and relationships				
Balance				
Unity				
Scaling				
Axiality				
Hierarchy				
Proportion				
Continuity				
Overlap				
Tangency				
Adjustment				
4 Finishing treatments				
Colour theme				
Colours relation				
Ratio of materials to colour				
Ration of dark theme				

Ration of light theme				
location of dark theme				
Location of light theme				

(Source: The researchers)

3. Application & Discussion

The results of visual analysis of façade for selected samples (figure 2) shows that facades of contemporary era affected by the new materials and technology of construction, which provided a platform to implement any design that architects produced. Also the regularity is the theme of the trend architecture in Mosul, which implement pure geometric shape in the façade such as square frames and rectangular frames.



Figure 2. Samples of facades designed by different designers (Source: 1: ArtDeco Architects, 2: Mosul Horizon for Architecture, 3: Azawi construction Company, 4: Aser Al Takwen for Architecture)

Vertical and horizontal organisational line are in balance with the perpendicular surfaces (figure 3), which usually is the

dark theme of the façade using wooden or dark gray marble. The principles of balance applied without reaching any type of symmetry (figure 4). Scaling principles used in 35% of the samples and applied for pure regular shape (figure 5).

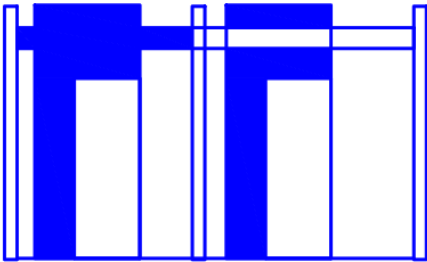


Figure 3. Vertical, horizontal, and perpendicular surfaces relations (Source: the researchers)



Figure 4. the imperfect balance by shape and void in the facade (Source: the researchers).



Figure 5. the scaling of pure shape in the facade (Source: the researchers).
The ratio of mass to void is 78%, which most of void ratio are applied in the

second level of the houses. The result of analysis highlighted that the relationships of intersection and overlapping are mostly used in the design. While the tangency is less than 8% for all samples. The principles of addition and subtracting from the façade form are observed in the analysis of the facades, which is mostly the results of intersections of the façade elements or created by creating the opening (doors, windows).

From the results of analysis, the second step of the study going to apply the rules that concluded from the results with few modifications to generate new models from one or iginal facades in order to examine the algorithmic process of the facades and draw out the rule and data set for the algorithmic process of generating new models (Figure 6).

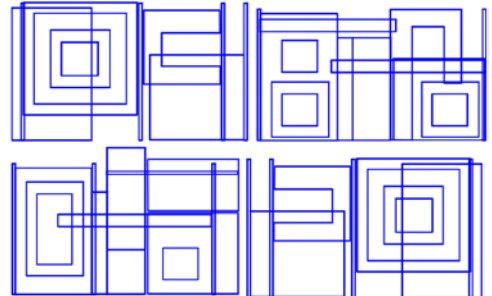


Figure 6. Some alternative models of facade generated from one existing facade (Source: The researchers).

The similarity checked between the produced facades and most similar facades are presented in (Figure 6). Although the new models is nearly matched by the elements and organizational lines, but the differences are in the implementation of the principles and rules on the original elements of the façade. Applying the colour and material theme, which mostly

applied the contrast relation with the façade main wall. The ration of contrast colour or material to the background wall are (3-1) and (3-3-1). The results of generating alternative models show that similarity in the design of façades for one designers can create a parallel trend for the designer and in the same time achieved the needs of the client in the following the trend of the facades in the city, this done without creating visual deformation in the image of the street because the source of the shapes and principles are same, but the relationships are totally affect the results of similarity.

4. Conclusions

Producing alternative models of facades is acritical process, because it could create positive or negative impacts on the new models in term of similarity and copy for a façade to create identical or semi-identical facades. Therefore, identifying the elements, rule, and principles in a systematic way following algorithmic steps to produce facades with aesthetic relationships and elements linked to the architectural trend of the city and carrying the specialty of the designer.

The algorithmic process and steps to generate alternative models of the contemporary façade included four main steps, which can be applied in any programing language with providing data set (figure 7). The first step is to select the overall frame of the façade (R1) and the depth of the void (R1-1). The second step to select the rule of shapes (R2) in the façade (background wall, vertical – horizontal- perpendicular surfaces, basic shape....etc) (r1,r2,r3.....rn) which

depends on tthe analysis of the facades that designer want to derive new models from it. Moreover, in this step the ration of area covering the façade from the selected shapes (R2-1). The third step is to define the principles (R3) and relationship (R4) for each selected element in the second step. The final step to define the colour (R5) and material (R6) with the ratio of contrast relations (R7).

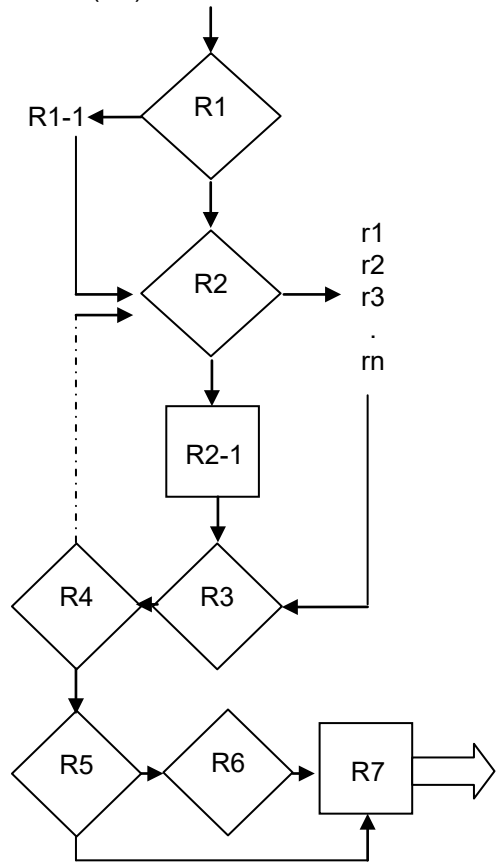


Figure 7. algorithmic diagram of generating alternative models (Source: The researchers).

5. Acknowledgment

The Authors Acknowledge the university of Mosul, College of Engineering, Department of Architectural Engineering for registering the paper by the scientific committee under the 2022-2023 researches plan reference no. 9/16/9046 in 8/11/2022.

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Demoscene Display Installation

Dr. A. Kudra

AoC Initiative, Germany | <http://demoscene-the-art-of-coding.net>
Echtzeit – Digitale Kultur, Switzerland | <https://www.echtzeitkultur.org>
Computerkunst e. V., Germany | <http://computerkunst.info>
e-mail: kudrix@kudrix.de



Dr. A. Kudra

Abstract

The Demoscene community intends to contribute to the 25th Generative Art Conference with an installation. The Demoscene is a digital culture active in many parts of the world. It is recognized as intangible cultural heritage by UNESCO in Finland, Germany, and Poland. We would like to present creative works out of this community – Demos – which show of what might emerge when creativity, algorithms and (programming) skills come together. To achieve this, we would like to install a display which runs most praised works of this community.

Wait, what's the Demoscene?

It's about demonstrating talent and skills of coders and capabilities of computing machinery. *Demosceners* produce *Demos*, digital audio-visual works rendered real-time by computer programs. Sceners strive for entering their programmed productions in a competition – a *Compo* – at a *Demoparty*. Self-limitation fuels creativity: Contributed programs compete in categories, with e.g. file size limits (size coding), hardware restrictions or historic computers (Commodore C64, Amiga, Atari ST, etc.). Demos are released live at these events, where they are celebrated and voted on by all visitors. The Demoscene is an internationally active digital subculture, rooted in the home computer revolution in the 1980s but vibrant to this day. Sceners are strongly attached to *their* Demoscene, there is a tremendous amount of identity, history, emotion, and community. No wonder it is recognized by UNESCO as intangible cultural heritage of mankind in Finland, Germany, and Poland (see <http://demoscene-the-art-of-coding.net>). More UNESCO applications are currently in preparation by Sceners.

Stop talking, show me Demos!

Demos are very hard to describe verbally, they are an audio-visual experience and are best enjoyed live at a Demoparty. But you can watch video recordings of some famous Demos at GA2022 at the Demoscene exhibition display in the hall. kudrix, a Demoscener will be around to answer questions you might have. Expect to be invited to a Demoparty! kudrix will also be giving a brief Demoscene intro as a presentation.

Remarks

The presenter is part of Art of Coding, abbreviated as AoC, an initiative to get the Demoscene recognized as first digital culture of UNESCO intangible world cultural heritages. He presented the article “Demoscene Dark Matter – The culture that makes people stay in the Scene” at the XXIV Generative Art Conference in Cagliari, Sardinia in 2021.

Resources

<https://en.wikipedia.org/wiki/Demoscene>

<http://demoscene-the-art-of-coding.net>

<https://wiki.aineetonkulttuuriperinto.fi/wiki/Demoscene>

<https://demoszoo.org>

<https://www.demoparty.net>

<https://www.echtzeitkultur.org>

<http://computerkunst.info>

Zebra: Threat and Response in a Dynamical Artwork

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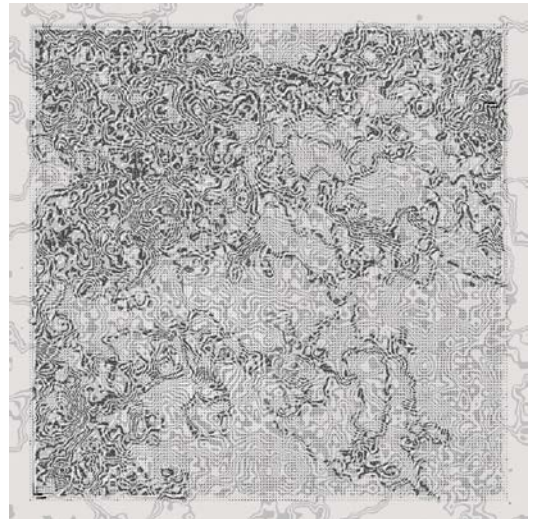
<http://littleumbrellas.net/>

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the overall resilience of the world. 'Zebra' models how history might affect agent responses to threat and how the ongoing behavior of agents under stress might affect their environment. The artwork explores whether agents who recall the past while responding to encounters are more or less likely to become negatively correlated with stress and what effects that correlation might



Abstract

This paper describes the artwork 'Zebra', an agent based system designed and implemented by the author. In this artwork, agents, or 'zebras', move over a noisy terrain where they perceive and respond to threat in the form of encounters. Depending on their reaction state, agents can respond to these encounters reflexively or freeze and deliberate their next action according to a history state which describes the outcome of their last encounter. Encounter outcomes are then fed back into the system where they contribute to

have on their environment.

Zebra (2022), screenshot, computational media.

Description

'Zebra' is an agent based system that explores the relationship between memory, environment, and agent response to encounters. The system is

designed around two main causal loops. One loop positively correlates with erratic agent behaviors such as seeking, fighting, and avoidance. A balancing loop negatively correlates with the effects of stress on agents by reinforcing stability in the environment. Stress is measured as the global noise level in the system. Stability is measured as how sensitive the world is to its collective damage.

'Zebra' initializes with its environment in a neutral state. Agents start off with random encounter histories and random behaviors. A roaming state determines each agents pattern of motion and its radius of perception. Agents set to wander move through the world in a wander state with no agenda. Agents set to avoid will maintain a maximum distance between themselves and all other world elements. Agents set to seek will 'target' another agent within their roaming radius and attempt to leave their wandering phase to enter an encounter.

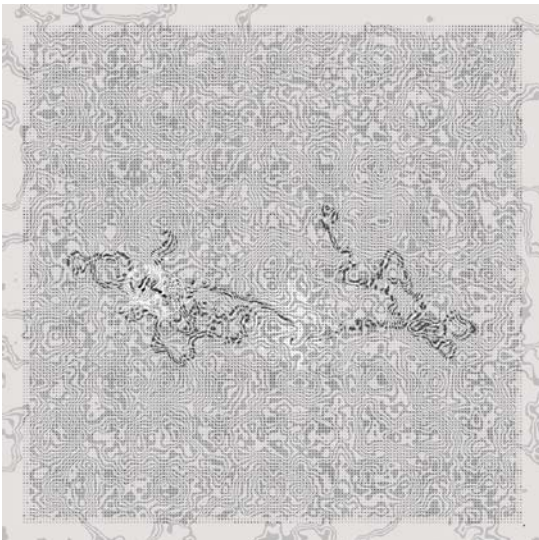
The outcomes of these 'encounters', or agent-to-agent collisions, are the main determinant of agent behavior. Some agents respond to encounters reflexively, choosing their next behavior at random. But other agents 'freeze' or stop activity on encounter. These agents consult a history state describing the outcome of their last encounter in order to decide a response to a current encounter.

Both reflexive and deliberative agents respond to encounters with flight, flight, or play. Agents who choose flight will take on a slight amount of damage and a slight increase in stability. Agents who fight and win are more likely to enter a seek behavior pattern. Agents who fight and lose are more likely to behave with avoidance. Over time, their movement in the world can become increasing avoidant and erratic. Agents who respond to an encounter with play will erase their history state and replace it with a wander state.

On time step, the damage and stability of the environment is calculated, along with the outcomes of agent encounters. Agent states and behaviors are updated.

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Zebra (2022), screenshot, computational media.

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Urban Codes

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Urban Codes

Abstract

Urban Codes

Several city related photographs and codes were juxtaposed and transformed into a musical score. Another app developed the same way as the first one, served for transformation on multiple levels. The binary soundtrack type of footage commences the video.

Urban Codes.

Photographs of urban scenes were the basis for both the video and audio of this work. An audio app developed by Stuart Smith extracted the essential outlines of each scene and used the resulting images as the “score” for sound generated by the app. A graphics and video app also developed by Stuart

Smith performed geometric transformation on sets of the photographs and then recolored the transformed images. These images became the principal frames of the video. In the final editing of the work, artists added additional graphic and audio material. The complex structure of the video—with its underlying set of rules, codes, and standards—depict complicated ways of living in a big city.

Quoting references

Main References:

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[2] Graphical Thinking for Science and Technology Through Knowledge Visualization (Advances in Multimedia and Interactive Technologies) Anna Ursyn (Author), 2021, IGI-Global

A Walk to Meryton : A Co-creative Generative work by Musebots and Musicians

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Abstract

A Walk to Meryton is a co-creation between a generative system and its creator, as well as three improvising musicians and a sound poet. Building upon previous generative systems [1, 2], the system is routed in composition rather than improvisation, in that plans (frameworks) are created, then filled in by musical agents (musebots) by creating a score; musebots can edit their individual parts, making decisions based upon global structures and local events by other musebots. The final score is performed by audio musebots, and a version of it is presented to musicians as a lead sheet consisting of harmonic progressions, melodies, and overall structure. Finally, an

additional set of videobots generate video using still images of various nature walks made by the author, overlaid with text from Jane Austen's *Pride and Prejudice* (the inspiration behind the entire work).

1. Background

Much of my creative research in the past decade has revolved around making my generative music systems more *compositional* rather than *improvisational*. My own attraction to generative systems is the opportunity for continual reinterpretation of processes to essentially create infinite versions of a single work; however, there is a delicate balance between limiting the immediate output of a closed system to produce similar results – what I might consider an improvisational approach – and one in which the limits are the result of what the system itself might produce – what I would consider a compositional approach.

My background is that of a composer rather than an improvising performer; composers tend to be concerned with the control of time through structure, while improvisers tend to be

concerned with an immediacy of production. I noted in my own non-generative output that, somewhat ironically, my compositional approach was often to begin a work through improvisation, then taking a slow and methodical approach to sculpting that material into time-based structures.

My earliest generative systems also tended to be improvisational: I would manually set up constraints on harmony, melody, rhythm, and other musical elements, and allow my rudimentary musical agents to explore the sonic potential of the space, stepping in when necessary to make subtle (or not so subtle) changes when I, as a listener, deemed the mercurial results to be getting boring.

The difficulty in automating such high-level decisions is due to the nature of the decisions themselves: they are aesthetic judgements made entirely based upon contextual relationships. A certain harmony may get boring quickly if not enough melodic and rhythmic variation is occurring, yet the same harmony may be acceptable if the particular concurrent melodic/rhythmic generation is deemed "interesting"; the issue, of course, is how to determine what is "interesting" in a given situation – computational aesthetics remains, for the time being, an open problem [3].

A realisation occurred to me several years ago when a research group I

was involved with began to consider generative methods of creating musical structure [4]; more specifically, it was a consideration of an alternative method of musical form, namely moment-form [5], which led to a proof-of-concept system described in 2017 [2]. The suggestion was to generate non-teleological structures by ignoring the Germanic tradition of formal development and embracing more static models found in various musical traditions, including ambient electronica, non-Western music, and experimental music as initially proposed by Stockhausen [6].

Most of my generative works since 2016 have embraced this method, generating entire musical formal structures prior to a performance, then allowing musical agents – musebots [7] – to fill in that form with unique details based upon their individual knowledge and abilities. Apart from being able to control high-level notions of formal repetition and variation, such a method allows individual musebots to benefit from having a musical precognition of the structure within which they are operating; knowing a section is two minutes in duration allows them to plan their activity within that time, for example.

A Walk To Meryton is my latest work that explores this compositional approach to generative music, with a new modification. One irony of my own exploration of generative works

is the acceptance that, despite having the potential to explore multiple versions of a work, there is a tendency to find one output that is tremendously satisfying and keep that single version as a type of exemplar. I was looking for a method that could retain key aspects of a work – its structure – while allowing new details.

With *A Walk to Meryton*, the system separates the generation of its structure – what I consider to be a *framework* – from the final result completed by the audio musebots – what I consider to be the *score*: frameworks can be saved, with new and alternative details filled in by the musebots. This is similar, if not identical, to how *leadsheets* have been historically treated by jazz musicians: the leadsheet specifies the overall form (the number of measures, which measures are to be repeated, etc.), the harmonic structure, and the melodies. With each performance, a jazz group will retain the overall structure of a song by adhering to a repeating form that utilises a specific harmonic progression and recognisable melody but will vary the improvisational contributions of the individual musicians. The song remains recognisable due to what is retained, but different each performance due to the varied details provided by the improvising musicians. Similarly, a work generated by *A Walk to Meryton's* system will generate what should be a recognisable form

complete with a unique melody and harmonic progression, capable of having multiple versions in "performance" provided by varied musebot output.

1.1 User Control

Before explaining the various parts of the system, a brief mention is necessary to underline the limited user control over the generation; there are only two overall parameters that can be set by the user: *valence* and *arousal*. These two parameters influence decisions made by all aspects of the system, as valence can translate into complexity, and arousal can translate into activity level [8].

2. Generating Structure

An overall structure is the combination of several different phrases grouped into sections; each phrase is composed of an individual rhythmic structure.

2.1 Tala and Phrase length

This rhythmic structure can be considered as a repeating cycle, or *tala*; rather than utilising the Western notion of a divisive pattern – a length of time divided into equal parts – this system uses the South Asian method of additive cyclical patterns.

The first decision made is determining the length of the tala cycle (i.e., how many beats in a measure), with high valence (i.e., lower complexity) favouring 16 beats,

and low valence (i.e., higher complexity) favouring an odd number of beats (i.e., 5, 11, 13, 7, 15). The limit of the tala is set at 16.

Next, a phrase length is determined: the number of individual cycles of each tala in a phrase. High valence favours 4 and 8 measures per phrase, while lower valence favours longer phrases (from 9 to 16).

In both cases, the actual valence generates a probability based upon the low and high valence vectors, and a roulette-wheel selection is used to select the individual values.

2.2 Generating Harmonic Progressions

For many years now, my generative systems have used a database of harmonic progressions using a corpus of jazz guitarist Pat Metheny's music [9]; Metheny's music is fundamentally tonal yet avoids many of the obvious progressions found in other jazz music. In its simplest form, a decision is made on the number of chords required in a progression (influenced by the number of measures in a phrase), adjusted by the overall arousal: a higher arousal would likely result in more chords in a phrase; a lower arousal would likely result in fewer chords.

Individual chords in the database are analysed for complexity, essentially the number of semitones and/or added extensions to the basic triad; a starting chord is selected from the

possible range based upon the overall valence. The database, organised for Markov generation, then provides all possible probabilistic continuations for the initial chord, with adjustments made due to the overall valence. Thus, while chord Y may be the most likely chord to follow X, the current valence may require a more complex chord, and thus the probability for chord Z would increase.

As with all Markov generative methods, a sequence of selections is produced that makes sense from individual-to-individual element (or taking more than just the previous chord into consideration if using higher order Markov selection), but with little or no direction. Harmony is, however, very much based upon directed motion [10], so generating a progression using Markov strategies, without a goal, is problematic.

A Walk to Meryton attempts one solution by recognising that many progressions, particularly in popular music and jazz, are circular: a section will often consist of a single phrase containing a harmonic progression that is then repeated, with the final chord of the phrase leading back to the beginning (or the next phrase). Thus, four chords, for example, will logically follow one another – A to B to C to D – and the fourth chord, D, will need to logically transition back to the first.

To accomplish a system of circular harmonic progressions, the chord generating system was run for hours, creating hundreds of thousands of chord progressions in lengths of four to eight chords; each ending chord was then tested for the probabilistic movement to the first chord. Those progressions that passed a threshold were retained in a database, and each progression was then rated for overall valence.

During generation, the system decides the length of progression (with a maximum number of eight chords possible within a phrase) based upon the overall arousal, and selects probabilistically from the database based upon the overall valence.

2.3 Sections

The above determinations – phrase length, harmonic progression – are made three times and stored, as the system generates an alteration of three possible sections: A, B, and C. In a related research project [11] it was determined that the vast majority of electronic dance music incorporates three basic sections: a main section (A) that operates similar to a verse in song form; a chorus-type section of high activity (C), and a low activity section that operates as a breakdown (B). Initial testing of structure generation limited to these three sections was found to produce enough variation coupled with balanced audible formal repetition.

A Markov probability table was created, by hand, to provide probabilities for each section. There are two additional sections – (I) for Introduction, and (O) for Outro; these are always (A) sections but with low arousal values.

An example probability vector for the first phrase (I) is as follows:

- 0.4 probability that it remain (I);
- 0.6 probability that it moves to (A);
- 0.3 probability that it moves to (C);
- 0.0 probability that it moves to (O);
- 0.0 probability that the composition ends.

A check is made to ensure that there are between three and sixteen phrases. An example structure generation could be as follows, given an arousal and valence of 0.4:

- I C C A A A B B C C B A B O

Repetitions of phrases are grouped into sections, thus the above phrase pattern results in the following overall structure of nine sections:

- Section 1 : I (Intro)
- Section 2 : C C
- Section 3 : A A A
- Section 4 : B B
- Section 5 : C C
- Section 6 : B
- Section 7 : A
- Section 8 : B
- Section 9 : O (Outro)

In this example generation, some sections consist of a single phrase (6, 7, 8), while the others consist of repetitions of phrases (i.e., Section 2, with two repetitions of phrase C).

2.3.1 Structural States

Once the overall formal structure has been generated, the states – on or off – for each musebot part is determined. Although the potential for self-organisation suggests that individual agents could determine on their own whether to perform within any section or phrase, an overriding "compositional approach" was favoured to ensure structural logic. Furthermore, the overall states and their unfolding over time contributes greatly to the perception of a single unified composition: the states are stored as part of the structure, so subsequent re-generations will contain the same states; for example, if the single Introduction phrase in the example above only contains a drone, a single Shapebot (described later), and a secondary percussion (also described later), each new generation will also only contain these parts.

There are eleven musebot parts: four Shapebots, Pad, Drone, Bass, Melody, Melody2, Percussion, and Percussion2. Each part has a probability for individual sections, set by hand, and adjusted by arousal. For example, the probability for ShapeBot1 in the Introduction is shown below:

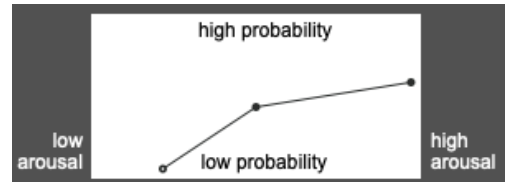


Figure 1. The probability for ShapeBot1 in the Introduction is determined by Arousal

The system will generate individual states based upon the current section, making sure that a minimum number of parts are active for that section. Once complete, a series of checks are made: for example, making sure that if specific parts becomes active in a given section, they remain active for the remainder of the phrases in that section; that within sections, phrases accumulate in activity level (i.e. the number of active states); and the elimination of duplicate phrases.

An example generation of track states is as follows:

		s1	s2	s3	s4	pad	drone	bass	mel	mel2	perc	perc2
0	I	0	1	0	0	0	1	0	0	0	1	0
1	C	0	0	1	0	0	1	1	0	0	0	0
2	C	0	0	1	0	0	0	1	0	0	1	0
3	A	1	0	0	0	0	0	1	1	0	0	0
4	A	1	0	0	0	0	1	1	1	0	0	0
5	A	1	0	0	1	0	0	1	1	0	0	0
6	B	0	1	0	0	1	1	0	0	0	0	0
7	B	0	1	0	0	1	1	0	0	0	0	1
8	C	0	0	1	0	0	0	1	1	0	1	0
9	C	0	0	1	0	0	1	1	0	0	1	0
10	B	0	1	0	0	0	1	0	0	0	1	1
11	A	1	0	1	1	1	0	1	1	0	0	0
12	B	0	1	0	0	1	1	0	0	0	1	1
13	O	0	0	0	0	0	1	0	0	1	0	0
14	end	0	0	0	0	0	0	0	0	0	0	0

Figure 2. An example of individual track states for a structure

For a complete framework, the talas, phrase lengths, and harmonic progressions for each section can be

saved, along with the above track states.

3. Generating Parts: Individual Musebot preferences

As mentioned, there are eleven different parts, and eleven different musebots that generate material based upon the generated framework. Each musebot has a particular function; given the valence and arousal for each phrase, musebots will generate their material and write them to a score, which consists of event specifications (i.e. note onsets and durations).

Prior to generating individual parts, a general melodic shape is generated for a work, which melodic musebots (ShapeBots) follow.

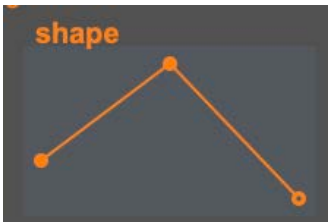


Figure 3. An Example Shape

The four ShapeBots interpret this shape when generating their melodic material. An example for three measures of ShapeBot1 using the above shape – displayed as piano roll notation – is given below:

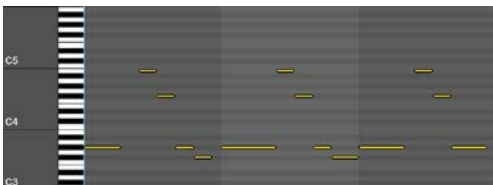


Figure 4. Piano roll notation for three measures of ShapeBot1

Compare this with the output of ShapeBot3 for the same three measures:

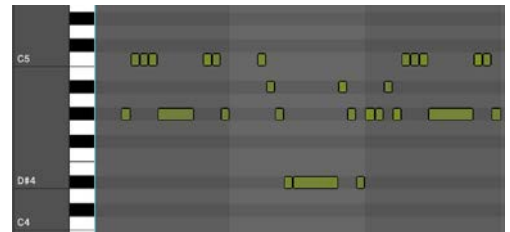


Figure 5. Piano roll notation for three measures of ShapeBot3

Hopefully it is apparent that the same melodic shape is generated by the two different musebots, however interpreted differently in terms of onset placement.

All musebots generate parts for the specific phrases set in the track states: each musebot writes its part as a clip in Ableton Live:



Figure 6. Generated clips for each part in Ableton Live

As mentioned, each musebot fulfils a separate function: the four ShapeBots provide melodic figurations based upon the composition's generated shape; the PadBot will generate held chordal tones; the DroneBot will generate long held pitches, attempting to minimise pitch changes by finding the

common chord tones between harmonies; the BassBot will generate bass parts; the two Melodic bots will generate melodies (using a corpus of Pat Metheny melodies and 2nd order Markov generation); the PerBots will generate rhythmic material.

3.2 Sound selection

Once every part has been generated, each musebot selects a synthesiser voice to perform its part. Several synthesisers are available – Absynth, FM8, Kontakt, Massive, Omnisphere, and a variety of Ableton and bespoke synthesisers – and each synthesiser’s preset sounds have been pre-analysed for spectral content, suitability, and range, creating a large database of available timbres. Each musebot has a distinct preference for specific patches within their available synthesisers.

Given a generated part with a limited pitch range, the musebot selects a synthesiser, then a timbre suitable to its generated part. Although there is a finite number of possible patch combinations, that number is very large; there are, for all practical purposes, a near-infinite number of possible sound worlds that the musebots can explore.

4. The Score

Figures 4 and 5 demonstrate how musebot write their parts into Ableton Live clips, which allows for this standard commercially available Digital Audio Workstation (DAW) to

perform the collective music. At the same time, each part is stored in a single collective score with each part’s onsets within the phrase, its MIDI pitch, velocity, and duration. This is stored along with the composition’s framework as one example output.

With a single collective score, each musebot’s data is available to every other musebot, allowing for musebots to make decisions based upon existing data. For example, the DroneBot examines the pitch ranges of other musebots active within a section and attempts to place its pitches in contrasting ranges.

5. Human Interaction: Improvising to Score

Although *A Walk to Memoryton* generates complete compositions, the intention was always to allow for human interaction by improvising musicians. As mentioned, the system generates a framework for each composition, and this can be translated into standard musical notation. Figure 7 demonstrates the first two sections of "Room for a Moment", displaying the tabla, the different harmonic progressions between the two sections, and the melody for the B section.

Room for a Moment

Tala: 2 2 2 4 3

♩ = 176

A Bbmaj9 Ebmaj9 Dm7 Ab7b5

B Dbmaj7 G13 Ab13

C#m7

The lead sheet for "Room for a Moment" is presented in two systems, A and B. System A consists of two staves of music with chord symbols Bbmaj9, Ebmaj9, Dm7, and Ab7b5. System B consists of three staves of music with chord symbols Dbmaj7, G13, Ab13, and C#m7. The notation includes treble clefs, a 10/8 time signature, and various rhythmic values such as quarter, eighth, and sixteenth notes, along with rests and bar lines.

Figure 7. Leadsheet for "Room for a Moment"

These scores were given to three musicians: trumpeter John Korsrud; saxophonist Jon Bentley; and violinist Meredith Bates, each of which are expert improvisors. I determined which instruments would play during which sections and provided the recordings to the musicians before individual recording sessions. In sections with notated melodies, they were given the option of re-interpreting the melody, suggesting it, or ignoring it.

During the recordings with the musicians, I made very few suggestions or comments, treating the human musicians as I did the musebots: giving each an abundance of creative space.

Poet Barbara Adler was also asked to contribute and collaborate; Barbara and I had long conversations about walking, Jane Austin, musebots, and internal dialogs. Barbara then added her own take on these ideas and provided readings.

6. Video Generation

The generated frameworks for each composition are used in the generation of video for each work in *A Walk to Meryton*. Videos are generated by selecting from a database of photographs taken by myself on various nature walks (see Section 7.1). The database is sorted into individual walks, with subdirectories based upon specifics of the walk; for example, "Daisies"; "Fallen Tree"; "Ferns". Each subdirectory requires, at minimum, five photographs.

Videos are generated in realtime, after the generation of all audio data. Prior to performance, the video system selects a directory, and selects one photograph for each section: I A B C O. When that section is played, the corresponding selected photograph is selected.

Motion within the video is created through panning and subtle changes in video processing. At the start of each section, an initial start location and final end location is generated, the distance between them determined by the section's arousal value.

The amount of processing is similarly determined by the overall valence of a composition; the processing itself – erode and dilate processes – selected to suggest a painterly result. A posterize process is then added.

Text from Austen's *Pride and Prejudice* is superimposed on the image in one of two ways: individual lines randomly placed on screen, or several lines written onto a virtual sheet which billows using physical models. In some cases, text written and spoken by poet Barbara Adler is used instead of Austen's; the actual text written by Adler is loaded, and the position within the overall composition determines which lines are selected. As the correlation is not exact, the effect is the text sometimes preceding the spoken word, and other times following it.

7. A Complete Generative Composition

The described system generates complete compositions, including selecting timbres for playback. As mentioned, the user is only required to adjust overall valence and arousal parameter values, click "Generate", and then wait for the result.

My own role has been limited to curating the final output. The system produces music results that I find deeply moving and beautiful; in generating the ten works for *A Walk to Meryton*, I found that I was able to generate one new work a day, rejecting perhaps three generations and accepting on average the fourth. I had to make a conscious decision to stop generating new works, as I continued to discover very successful musical results. In the end, *A Walk to Meryton* consists of ten individual

works, ranging in duration between four and ten minutes; the ten tracks eventually will be released on vinyl (a determining factor on the ten-track limit).

The collaboration that I have enjoyed with musebots, such as those within *A Walk to Meryton*, is discussed in detail elsewhere [12]; suffice to say, I consider musebots to be more than tools used in the creation of new music, but collaborative partners that have allowed me to produce music that I've always wanted to hear.

7.1 About the title

I will readily acknowledge that I have a very hard time coming up with titles for my compositions, generative or otherwise. As a result, I have used an algorithm to generate titles for almost a decade. Using a variation of the Markov algorithm described in Section 2.2, the complete text of Jane Austen's *Pride and Prejudice* – raw text that has been on my computer for many years – has been analysed for continuations. To generate a title, the algorithm selects a random word from the database, then produces a fixed number of continuants. When the first test score for this new system required a title, one of the generations was the phrase "A Walk to Meryton"; I decided that this was an ideal evocation of the emotions possible by the system: solo walks through nature, an individual lost in contemplation. Each movement had

its own title generated in the same way.

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A Walk to Meryton : Installation of video & sound

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Proposal

A *Walk to Meryton* consists of ten videos of generative music and visuals, approximately one hour in length. The video loops.

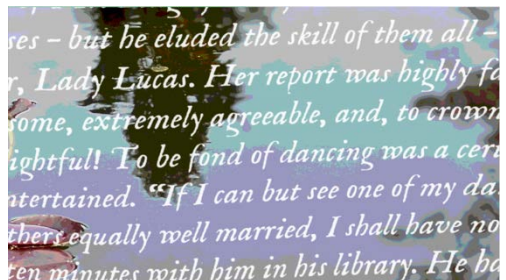
The videos can be experienced either on a large monitor and speakers, projected, or with headphones.

1. Example Video

The ten video tracks can be seen here:

arneEigenfeldt.wordpress.com/a-walk-to-meryton/

2. Example Images from video



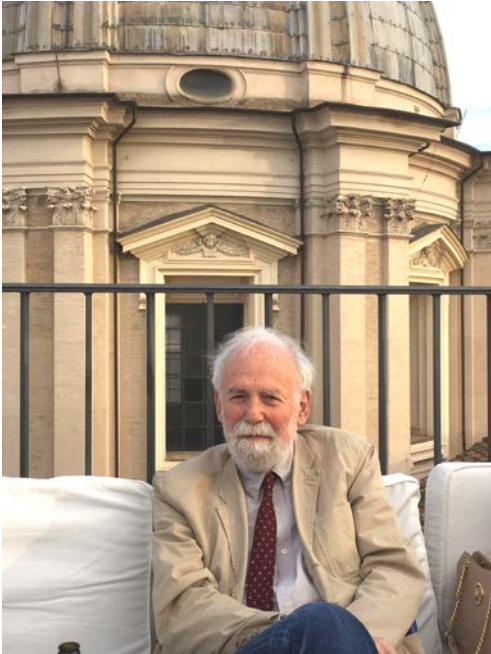
Abduction from Borromini. Generative interpretation of the façade of “Oratorio dei Filippini”

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Celestino Soddu

Abstract

The façade of “Oratorio dei Filippini” by Francesco Borromini is one of the most interesting baroque masterpieces. This year we run the 25th Generative Art conference there, in the Borromini Hall of this building. Following that I tried to perform a generative interpretation of this façade for setting up a species of

facades able to generate endless unique results following this interpretation.

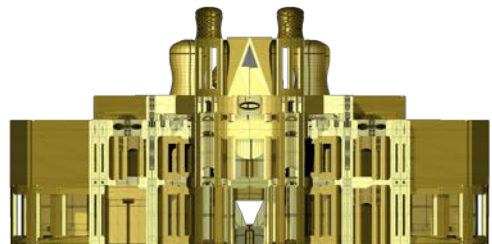
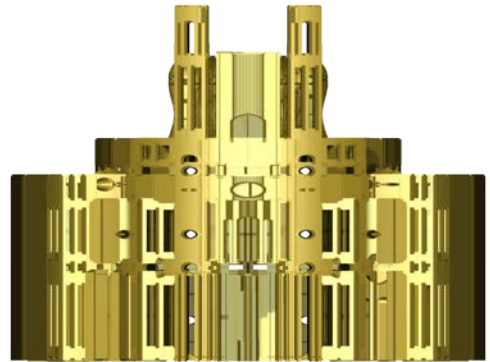


Oratorio dei Filippini façade

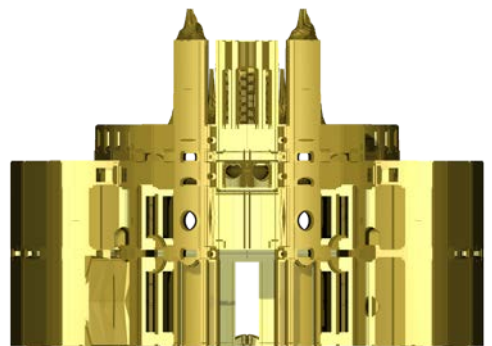
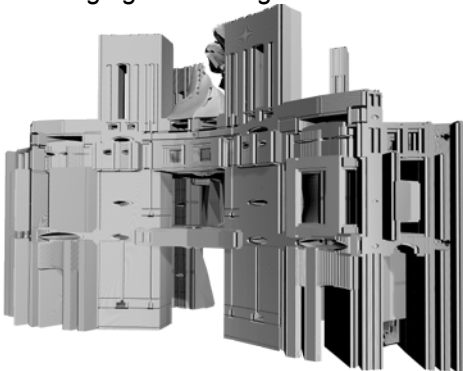
My goal was to investigate the distinctive characters of this facade, the logic behind its particular geometry, and the structure of the three-dimensional rhythmic sequences created by Borromini. I constructed a topological paradigm that interpreted these characters and the type of relationship

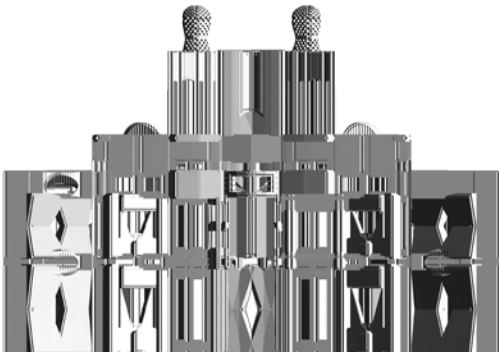
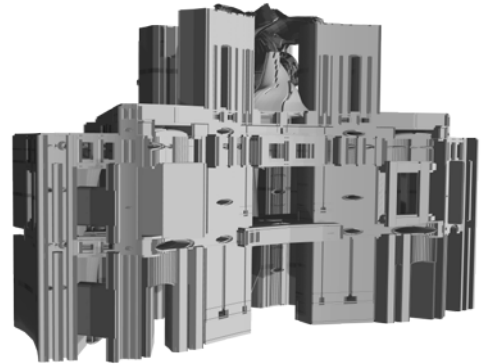
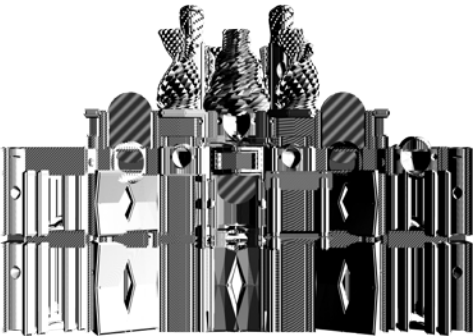
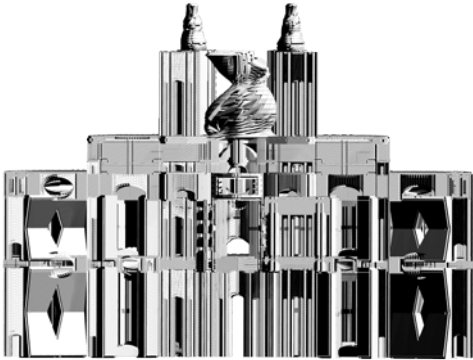
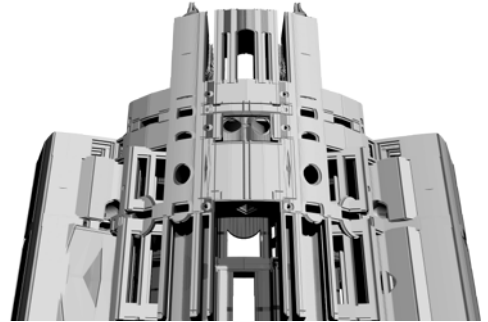
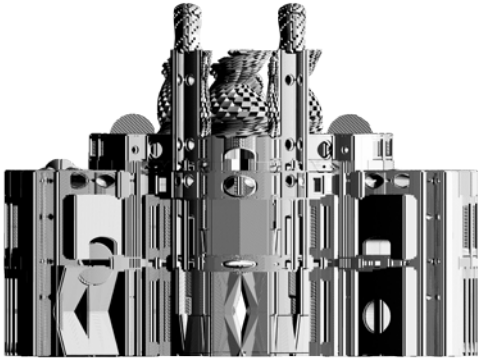
existing between the elements of the facade. Specifically, the relationship between the window planes, the perforations, and the axis of the façade. The interpretation of these relations render explicit the geometric rotations and curvatures that build rhythm starting from the central axis.

The result was a topological paradigm that tends to produce events and relations between events in a way that is recognizable as baroque, as a tendentious reading of Borromini's work but also capable of reflecting an architectural vision that is recognizable in my architectures. No form of Borromini's architecture was reproduced in the generated results, but only the Baroque topological identity, or rather the aspects of this character that reflect my interpretation of Borromini. More, I have added to the topological paradigm other characters that have always been dear to me. They are present in Borromini's work, such as the double bell towers and domes close to the facade, present in Sant'Agnese in Piazza Navona.



Following figures: The generated facades





Modularity and Generative Art

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Abstract

Modular tools and processes often occupy significant roles in various types of generative art practices, whether implemented in hardware or software.

This paper provides a definition of modularity, a brief history of modular systems and examines a range of modular strategies in order to discuss what aspects may make different modular paradigms more or less conducive to generative work.

Issues of intention, connectivity, complexity, structure vs. content, and overdetermination are discussed in the context of the effectiveness of different modular paradigms for generative work.

Introduction

The aim of this paper is to introduce modular artmaking systems and make a first run at an exploration of the history

and special characteristics of a particular concept of connected modularity and how its instantiation as specific modular systems—in hardware, software, and hybrid forms—may be particularly well-suited to pursuits in generative artmaking. The enormous popularity of node-graph-based modular metaphors (the abstracted software side of modular, hereafter referred to just as ‘node-based’) in art-making tools and systems, particularly those with significant capacity for autonomous operation, points to an at least perceived affinity between modularity and generative art. The evolution and typical characteristics of these systems is examined in this paper with a particular emphasis on modularity in sound synthesis as represented by the Eurorack format, both physical and virtual.

Defining Modularity

Modularity is broadly defined by Melissa Schilling as “...a continuum describing the degree to which a system’s components can be separated and recombined, and it refers both to the tightness of coupling between components and the degree to which the ‘rules’ of the system architecture enable (or prohibit) the mixing and matching of components.” [1] Although Schilling’s primary interest is in developing a general theory of how and why systems become more or less modular over time, this definition and subsequent terminology, borrowed from a variety of

disparate fields, is a reasonable starting point for considering modular artmaking systems.

An important consideration in a discussion of the suitability of particular modular systems for generative work involves what Schilling calls *synergistic specificity*: “The degree to which a system achieves greater functionality by its components being specific to one another.” [2] At the extreme low end of synergistic specificity, modules are utterly agnostic in terms of their preferred connections to one another. This leads to far greater freedom in recombination of modules (and implies a general and limited scope of functionality per module) but comes with a possible loss of optimal functionality at the system level. Conversely, high levels of synergistic specificity may contribute to more optimized overall system functionality, but at the cost of overly opinionated modules (more on this later) and much more severe restrictions on recombination possibilities.

In the terms of generative art, however, it is critical to interrogate the implications of what precisely is meant in this theory of modularity by “optimal.” A central tenet of making generative art with autonomous systems is that the artist must cede some degree of autonomy to the system [3]. This giving up of autonomy, among other effects, creates a capacity for the artist to be surprised by the system’s output—something that would certainly be understood as much less than “optimal” in Schilling’s management context.

One implication of a decrease in re-combinatory possibility with an increase in synergistic specificity is that composability, and thus the condition of possibility for “type 2” [4] emergent

behavior (that which does not arise from any one component in isolation, but only in the connected aggregate) may be lost. I would argue that, for the purpose of generative art, encouraging the possibility of emergent behavior in a system through more promiscuous (and less opinionated) modules is to be desired over efforts toward synergistic specificity in service to an optimal system.

The collection of modules for use in a particular modular artmaking system will often exhibit a range of different functions, purposes, or capabilities with fuzzy edges—some purposes will be unique to one particular module, and some, with varying degrees of overlap, with other modules available to the system. Modules in these types of systems are not designed primarily to be swapped-out with other identical modules (in case of failure or for production efficiencies as is the case in a manufacturing concept of modularity) but rather to offer shades of difference to a particular function or transformation in the flow of a modular system. This expressiveness of transformation is enhanced within a system possessing modules with multiple variations of a single purpose or function, facilitating experimentation by exchanging modules with different but similar functionality or effect.

At some level, children’s building blocks, both traditional wooden sets and those snap-together plastic ones (as well as tangrams, other tiling systems, and even strung beads) might meet the criteria of generative modular system as so far expressed. But while these examples may provide a limited platform for working generatively with autonomous rules systems, they lack the feature of

components communicating with each other within a modular system.

In Schilling's definition, the word "coupling" highlights that in a modular system the individual components must be somehow connected one to another—due to the limited functionality of each individual component, a module in isolation (by design!) is seldom useful.

Connections, whether linear, branching, or recursive, imply a flow of signal or data and define the relationships between and among connected components that shape the higher-level behaviors of a given modular system.

One effect of these two characteristics taken together (a multiplicity of modules and the necessity of connection) is that spatial arrangements and connective topologies often become significant factors in the way a modular system used in artmaking both presents and functions. The "rules" or "system architecture" of an autonomous rules-based system may be external but are often encoded directly into the number and manner of possibilities for connecting modules—whether through arrangement and number of inputs and outputs, connection types or "flavors," or spatial or type constraints imposed by the scaffolding or matrix within or upon which modules in the composite system must be placed.

The generalized modular system under discussion in this paper then consists of a collection of discrete components (modules), of usually limited functionality or purpose each, connected together in some way, which may receive and/or send data and/or signals through those connections, and which are also sometimes contained in some sort of organizing and/or connecting matrix.

The Site of Modularity

Where then might we situate modularity? It seems that modularity is quite obviously a property of the module. And yet, in the field of graphic design, practitioners often work with a 'modular grid' for page layout where the property of modularity rests primarily in the organizing matrix rather than in the content placed within it (which are modular only to the extent that they are spatially constrained by the grid system). In architecture a modular plan is defined by some sort of spatial unit. This confusion of language may have come about since earlier usage of the word 'module' linked it to a measure (the modulus) rather than the thing measured today. In the case of Eurorack modular synthesizers (which we will come to presently), it is interesting that hardware modules themselves come in a number of standard widths (called 'hp' or horizontal pitch) but only a single height of three units (3u) so that they fit into the uniform rack rails that are the system's containing and organizing matrix.

A (Rather) Incomplete History of Modular Systems

Heterogenous, physical "box-and-wire" modular systems originated from the needs of early electronic lab and radio test equipment, telephony systems, and most notably from the 1950s electro-acoustic studios of *Westdeutscher Rundfunk* (WDR) in Cologne, *Groupe de Recherches Musicales* in Paris, and the *Studio di Fonologia Musicale* of Milano (the Milan Electronic Music Studio aka RAI Studio of Phonology) where standalone oscillators, function generators, filters etc., housed in large sheet metal cases, were connected together to produce early electronic sound and music. To get an idea of the sort of equipment used in those early days and how it sounded, please see

Giorgio San Cristoforo's *Berna 3* software [5].

A decade or so later across the Atlantic, these systems began to evolve toward their now more familiar form on the east and west coasts of the United States.

The first system that could be described as a modular sound synthesizer was invented by German Engineer Harald Bode while working for the Estey Organ Company in Battleboro, Vermont in 1959. [6] Called the *Audio System Synthesizer*, Bode's somewhat ungainly machine reimagined the room-sized electronic music studios as a more-or-less portable unit with arrays of input and output jacks with which one could use short wires (with plugs on each end) to connect the various oscillator, filter and amplifier modules in a multitude of easily reconfigurable states or "patches."

Directly inspired by Bode's innovation and developing more or less independently on the east and west coast throughout the late 60s and early 70s, the modular audio synthesizers produced by Robert Moog and Don Buchla further miniaturized and popularized the concept of a portable modular system. Buchla, especially, seemed to have already seen these smaller modular systems as potential platforms for generative work rather than traditionally performed instruments: the Series 100 product eschewed a standard keyboard in favor of various sliders, knobs, and touch-sensitive controls meant to trigger and modulate sequences and parameters. Today, "west-coast" synthesis remains synonymous with a more experimental, often generative, approach to sound design and music using non-traditional controllers and inputs.

It wasn't until 1996 that Doepfer released the A-100 modular system with a format

that came to be known as Eurorack. This physical form-factor is now the most dominant (and de facto standard) modular audio synthesis hardware system, and arguably the paradigm most often referenced in the multitude of software node-based interfaces (including both the screw-head-literal and the abstractly metaphorical) that now exist for visual coding environments, sound design software, visual effects and compositing tools, and even 3D modeling programs.

One of the earliest of these on-screen node-based modular systems was the *GRaIL* (Graphical Input Language) software system described in a September 1969 memorandum prepared by the RAND Corporation for ARPA. [7] This novel "Experiment in Man-Machine Communications" employed a light-pen that enabled a user to sketch out algorithms as a collection of box-like modules—connected in the style of a flow-chart—directly onto the glass face of a cathode ray tube monitor. The "flow process chart" was already a familiar fixture in engineering circles, having been introduced to the American Society of Mechanical Engineers by Frank and Lillian Gilbreth in 1921 [8]. But beyond being a sophisticated drawing tool producing for flow charts, *GRaIL* was performative...it could also directly execute the algorithms sketched by the user: the visual block diagram of the structure of the code was also the code itself. This ahead-of-its-time system contained much of the DNA for the many subsequent node-based software interfaces that would follow it.

In 1985, at IRCAM (*Institut de recherche et coordination acoustique/musique*) in Paris, Miller Puckette began work on a graphical programming environment that would eventually evolve into two distinct

lines of software that have come to be known as *Pure Data* (1996) and *Max/MSP* (1997). [9] *Max/MSP*, a commercial product from Cycling '74 (part of Ableton since 2017) and *Pure Data* (often abbreviated to *PD*), a free and open-source cousin to *Max*, perhaps best embody the tangled heritage of node-based modular software systems that grew both out of performative algorithm-defining flow charts and graphical metaphors for interconnected signal generators and processors. This is most obviously manifested in the graphically differentiated communication “wires” in the applications that represent control and signal flow with distinctly different appearances (signal wires in *Max/MSP* are striped and “furry,” while control wires are smooth grey vectors).

In fall of 2017, in conjunction with KnobCon, a Chicago-based modular synthesis convention, Andrew Belt released the initial beta version of *VCV Rack*, a virtual modular Eurorack synthesis platform including software emulation of both physical commercial hardware modules and entirely imaginary ones, variably transparent virtual patch cords, and an infinite simulated modular case with visible rack rails.

Though not the first virtual modular software synth (Native Instrument's *Reaktor* (originally released as *Generator*) has been available since 1996), the free version of *VCV Rack* (now on version 2) is maturing into both a viable alternative to hardware Eurorack, as well as a useful compliment through MIDI to control voltage and control voltage to MIDI modules and circles the story of modular interfaces firmly back toward where they began in sound synthesis.

Eric Hosick has compiled a list of over 100 “visual programming languages” with a screenshot (and an occasional video) of each interface in action. [10] Almost all of these examples qualify as some sort of modular system, and taken together, exhibit an absolutely bewildering array of graphical styles and implementations of the modular metaphor underscoring the proliferation of this way of thinking and working.

The Lure of Modularity

Simply dividing a process into smaller units—say, for analytical reasons—almost immediately suggests new generative possibilities through the selection and recombination of those units. Such was the case with Vladimir Propp, who famously proposed a series of analytical functions that could be used to describe and classify existing Russian magical fairy tales in his 1968 book *Morphology of the Folk Tale*. Somewhat less famously (and even unknown to some who later worked on similar systems), Propp also described a method to use his functions to generate entirely new fairy tales in what Pablo Gervás argues may be one of the earliest documented descriptions of a creative process described procedurally. [11] There seems to be something about units of story, dis-integrated from their specific narrative arcs, that stimulates a human desire to recode the modular parts into new patterns.

Long before Propp, fortune-telling methods like the I-Ching and the Tarot used modular units to procedurally generate small divinatory narratives. But roughly contemporaneous with Propp, Bode, Buchla, and Moog were developing an altogether different kind of generative modular process based on analytical tools—modular sound

synthesizers inspired, in this case, by deconstructing and re-combining features of radio test equipment originally meant for analysis. The metaphor of 'patching' modular synthesizers, in turn, has spawned generations of the previously mentioned visual programming environments, including those like *Pure Data*, *Max/MSP*, *Touch Designer* and *vvvv* that rely on modules (and their connections) to express and create algorithms; these environments in particular are often used to conceive and produce generative artwork.

Modular systems are especially useful for algorithmic generative art because they tend to be rules-based at multiple levels—both within an individual module, where parameters may be defined, exposed, and modulated, but also at the level of the whole interconnected system of nodes, since the node graph (or patch) will, taken in its entirety, itself describe a larger rules system.

The legibility of the flow of a whole system (at least in simple patches!) is often a better situation for people who have a preference for (and developed skills in) visual understanding than text-based coding would provide. Patching patterns may suggest themselves in terms of visual proximity, alignment, balance, symmetry, or rhythm that might not be apparent when working with a text-based coding language (in the case of software) or menu-diving (in the case of non- or less-modular digital hardware).

The ability to make small changes within a module, or (more often) in the connections between modules, that nonetheless results in large and potentially unexpected changes to the overall behavior of the rules system/patch can be rather seductive.

Modular systems also both encourage and constrain an artist in potentially constructive ways. They provide encouragement because they expose a combinatorial palette for composing algorithms or rules systems as a sort of "kit-of-parts" that may help express intent by hinting at what is possible within the system, as well as avoiding the need for the artist to recall with great precision all of the commands and syntax native to text-based programming environments. Node-based systems also seem to tickle that particularly *homo narrans* [12] itch to create a sort of narrative flow from small parts; call it the "joy of patching."

Constraints can be useful too, particularly when they are baked into the way modules may be connected so as to prevent, in real time, connections that would inevitably lead to undesirable outcomes rather than after-the-fact syntax or compile-time errors. Some modular systems meant to teach children coding (such as MIT's Scratch and Adafruit and Microsoft's *Make Blocks*) keep the kit-of-parts philosophy but forego the boxes-and-wires node graph interface in favor of color-coded puzzle pieces whose shapes are keyed in such a way that they can only be assembled in ways that make syntactic sense. Other systems, like Blender's node-based material editor have color-coded inlets, outlets and wires that visually distinguish data types such as RGB color data, XYZ vector data, complete shaders or single numeric values.

Many node-based systems have modules that evaluate simple logical operations such as AND, OR, NOT, and XOR (exclusive OR) and others that compare signals or data to one another or a fixed value at specific intervals for conditional operations like $>$, $<$, or $==$. These modules, when connected to other

modules generating periodic, chaotic, or random values can be used to create complex behaviors from simple rules to generate sound, images, geometry, motion, video, etc., or to modulate the parameters of other modules, modulate other modulations, or even modulate themselves. This last capability is particularly useful for generative work, since various forms of feedback or recursion, mixed with other inputs and modulation, can be an extremely effective generative strategy across many forms of media and may give rise to emergent behaviors that are difficult to precisely predict.

A common source of modulation in node-based systems is the LFO, or low-frequency oscillator. These modules produce one or more wave functions or different shapes that can be used to describe rising and falling action over time spans ranging from audio range (so that they may be heard as a tone) up to much longer durations, including a tongue-firmly-in-cheek *Seriously Slow LFO* for *VCV Rack* from *Frozen Wasteland* that has time base settings ranging from “YEARS” to “HEAT DEATH” [13].

Other useful elements for generative strategies in a node-based environment include patchable sources of chaos (like pendulum and orbital mechanics simulations, Lorenz attractors, fractals, etc.) as well as some sources of uncertainty, such as Bernoulli gates (which shunt an input value to an A or B output based on a (selectable and modulable) probability), various colors of noise functions, and sample-and-hold modules that periodically dip into a stream of values (random or otherwise) and present what returns at an outlet.

Sequencers, a staple of audio synthesizers, are modules that emit a series of fixed values/voltages/colors when ‘banged’ or clocked. These are especially well-suited to generative serial composition strategies, especially when the sequence length is modulated by a second module, or multiple sequences are that are interleaved based on chance operations or other chaotic sequences.

An effective modular system for generative work then will include a large (but not too large!) set of simple, composable modules with multiple variations of common functions, that possess somewhat opinionated connections, and allow for conditional operations, recursion (feedback), complex modulation and chance operations.

Some Drawbacks

Node-based environments are notoriously difficult to “read” once they reach a certain level of splayed-noodle complexity. The same visual and spatial relationships that make node-based systems so powerful and legible to begin with also make maintaining anything beyond a fairly simple patch—or making sense of a patch authored by someone else—particularly challenging. Methods of leaving comments in a patch or documenting its structure do exist in many node-based systems, but often they either feel like afterthoughts, are poorly implemented, or both. Color-coding of inlets, outlets and wires (either baked into the system or as a published convention) can also mitigate visual confusion but is not a completely effective solution.

Modular systems that provide some method of sub-patching (roughly analogous to functions in other text-based programming) ameliorate the

tangle of spaghetti and give a clearer high-level view of a patch, but at the cost of low-level visibility and understanding, essentially making brand-new, functionally overloaded, components.

Indeed, if individual modules are too multifunctional (either by original design or as the result of sub-patching), it becomes easy to lose situational awareness in a patch and also disincentivizes quick substitution of similar patches for experimentation purposes (because too many collateral parameters/interior modules would be lost in the swap).

This is where text-based programming languages shine: a complex but well-commented program with rationally named variables and functions is relatively easy to read, maintain and confidently modify when compared to a complex modular system.

Back on the hardware side of modular, both audio and video synthesis modules tend to be quite expensive on their own. Generally ranging from 50 USD each for the simplest passive modules and up to 1000 USD each (and beyond) for the most sophisticated ones. And since a modular system needs an abundance of modules to be effective, for most people, a hardware Eurorack system is a significant expense.

When It Emerges from the Skronky Murk, the Krell is a Writhing, Cavorting Phantasm

In the 1956 sci-fi film, *Forbidden Planet*, a rescue mission to Altair IV reveals the remnants of an alien civilization, the Krell, in the form of an enormous subterranean machine and a half-million-year-old recording of a performance by Krell musicians. The soundtrack for the film, including the Krell music, was recorded

by Louis and Bebe Barron using a collection of hand-made electronic instruments and tape manipulation. Even though the film's release predated Bode's experiments with modular synthesis by a few years and did not use any sort of modular patching technique, creating some version of a "Krell patch"—a generative self-playing system in modules—has become something of a rite of passage for both hard- and software modular enthusiasts after being popularized by west-coast modular synthesist Todd Barton around 2012. [14]

"Krelling" is now something of a generative modular 'hello world' exercise in that it shows that both the modular system and its patcher can perform in a generative idiom.

This fanciful ritual—intuitively recreating and extending the imaginary music of a long-dead fictional race—is achieved canonically through the use of a pair of looping amplitude envelopes (preferably ones with end-of-cycle triggers) and a chaotic or random source for pitch information.

As many variations of this patch now exist as there are people who patch it, and for many, "Krell" is as much a synonym for generative or self-playing patches as it is a specific modular configuration.

The longevity and prevalence of the practice is evidence of the generative tendencies of modular systems (it is difficult or impossible to manage to Krell on synthesizer which is not at least semi-modular) and speaks to the joy of patching.

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modularity." *Academy of management review* 25, no. 2 (2000): 312-334.

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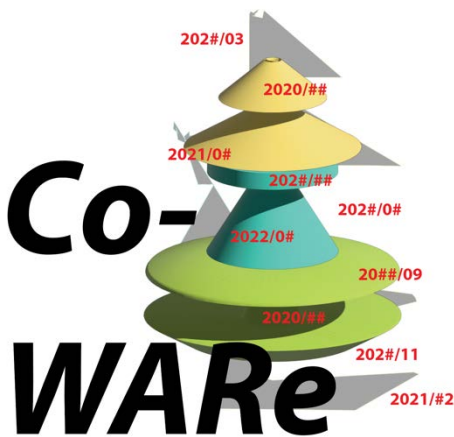
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(Co - WARE) Artworks for GA2022

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Abstract

Throughout history, humans have been creating receptacles in their daily activities to hold, keep, and preserve the rewards and objects they treasure. Applying the same notion, Co-WARE makes unique receptacles from covid data to express the information in an artistic form.

Co-WARE is an objectified presentation of all COVID-19 cases, deaths, geographically located data in each country, and the time of the data was generated. These data series project the

different changes brought to each country since the beginning of COVID-19. It also provides more intuitive insight into the epidemic in all countries worldwide.

Statement of Work

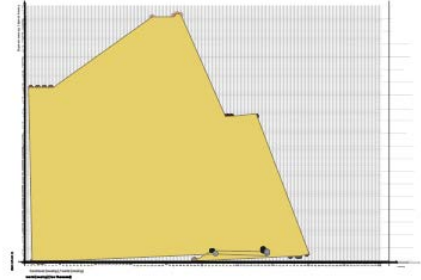
Co-WARE refers to the process of converting data into a visualisation. The combination of dots, lines, planes and colour collocation form an interesting visual effect that drives and stimulates the public's personal experience of COVID-19. The addition of colour saturation also makes the overall impact more three-dimensional. Furthermore, it distinguishes the similar colours generated by similar data in different countries, making the Co-WARE more tangible and structural in subsequent production.

Chart Method

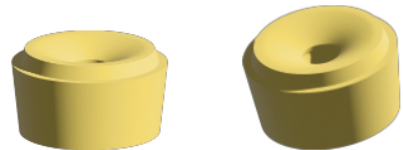
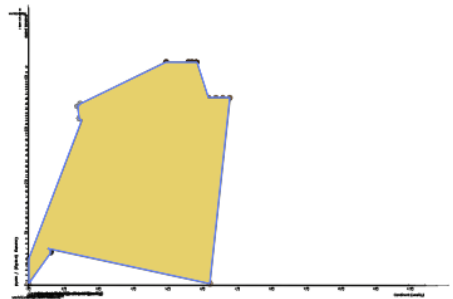
The Covid data were obtained from the WHO website (World Health Organisation). All data is charted on the graph to form a shape to warp into a 3D form. Nine data points were obtained from confirmed cases and deaths, respectively. The nine coloured points were connected to form a shape on the graph. The points were acquired from the formula charted (X Axis / Y Axis) on the graph.

- 1: World case (weekly) / Country case (weekly),
- 2: (Country case (Weekly) / World case (Total)) / (Country case (Weekly) / World case (Weekly)),
- 3: (Country case (Weekly) / Continent case (Total)) / (Country case (Weekly) / Continent case (Weekly))
4. (Continent case (Weekly) / World case (Weekly)) / (Country case (Weekly)/Continent case (Weekly))
5. Continent case (weekly) / Country case (Weekly)
6. (Country case (Weekly) / Country case (Total)) / (Country case (Total) / Continent case (Total))
7. (Continent case (Total) / World case (Total)) / Year (Weekly)
8. Continent case (Weekly) / World case (Weekly)
9. (Continent case (Total) / World case (Total)) / (Continent case (Weekly) / World case (Weekly))










Example: Confirmed Case Data



Example: Death Case Data



CONFIRMED CASE AND DEATH DATA CHARTING LOGIC

	X Axis	Y Axis
	World (weekly) [Ten Thousand]	Country (weekly)
	Country (weekly)/world(Total)	Country (weekly)/word (weekly)
	Country (weekly)/Continent(Total)	Country (weekly) / Continent (weekly)
	Continent (weekly) / world (weekly)	country(weekly)/continent(weekly)
	Continent (weekly)	Country (weekly)
	Country (weekly) / Country(Total)	Country(Total)/ Continent (Total)
	Continent (Total) / world (Total)	2020 (weekly)
	Continent (weekly)	World (weekly)
	Continent(Total) / world(Total)	Continent (weekly) / world (weekly)

Example:

Colour Allocation

The colour is generated by combining the **CMYK** value (**C** represents Confirmed Case, **M** represents Geographical Location Coordinates (**MAP**), **Y** represents Time (Day, Month or **Year**), and **K** represents Number of Death(Black to represent death) to form a unique colour for each respective data set. Temperature data were introduced to add saturation to the colour.

Example :

Colour allocation for February 2020.

C – Confirmed Case

Data use from the highest case day in the month

Equation = Highest Case Number on the Country day /Global data of the same day

The highest case day in the month **February** is on the 31st

31/02/2020, USA, 31 /
31/02/ 2020 Global data, 8247.

$31/8247 \times 100 = 0.37.$

M – Percentage of Country land mass to the overall world land mass

Date gather from https://en.wikipedia.org/wiki/List_of_countries_and_dependencies_by_area

USA land mass in percentage is **6.3%**

Y – Date of the Date

Formula:
 $100\%/12$ (12month) = 8.3
Month Order x 8.3

February is the 2nd month.
Therefore, $2 \times 8.3 = 16.6$

K - Death Case

Data use from the highest case day in the month

Equation = Highest Case Number on the Country day /Global data of the same day

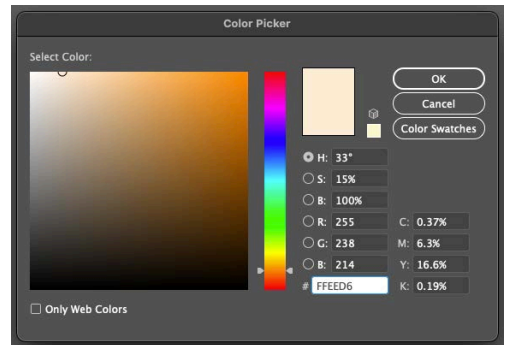
The highest case day in the month **February** is on the 31st

31/02/2020, USA, 1 /
31/02/ 2020 Global data, 520

$1/520 \times 100 = 0.19.$

C = 0.37, M = 6.3, Y = 16.6, K = 0.19

The generated colour :



Generated Colour :



C = 0.37, M = 6.3, Y = 16.6, K = 0.19

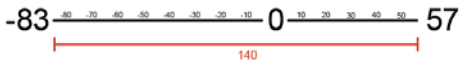
To add more depth to the colour, an value was added to the saturation of the generated colour base of the temperature. (Highest temperature of the day for the month.

The global minimum temperature is -83 degrees Celsius, and the global maximum temperature is 57 degrees Celsius.

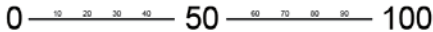
<https://weatherspark.com/>

To acquire the saturation value, An equation is used to convert the temperature value to the saturation value. used on the generated colour.

Temperature Range Lowest and Highest in record on earth.



Color Gamut (%):



Equation:

$$\frac{140}{100} = \frac{x+83 \text{ (temperature)}}{y \text{ (saturation value)}}$$

Example: 10°C -

$$\frac{140}{100} = \frac{x+83 \text{ (temperture)}}{y \text{ (saturation value)}}$$

$$\frac{140}{100} = \frac{10+83}{y}$$

$$\frac{140}{100} = \frac{93}{y}$$

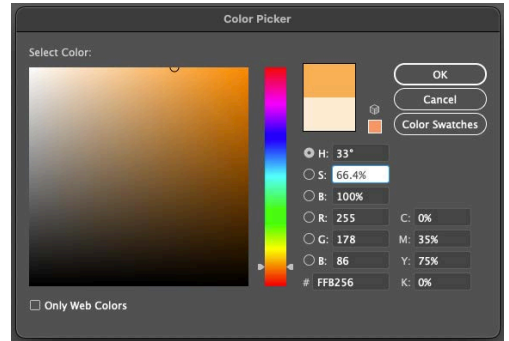
$$93 \times 100 = 140 \times Y$$

$$9300 = 140 \times Y$$

$$9300/140 = Y$$

$$66.4 = Y$$

Saturation Colour (66.4% Saturation) :



Colour with saturation : 



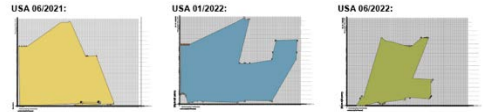
CMYK.
without Saturation



CMYK
With Saturation

Examples:

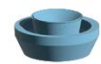
USA - Confirmed Case - 06/2021, 01/2022 & 06/2022



USA Jun:2021:



USA Jan:2022:



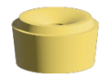
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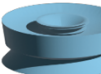
USA - Death - 06/2021, 01/2022 & 06/2022



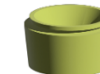
USA Jun:2021:

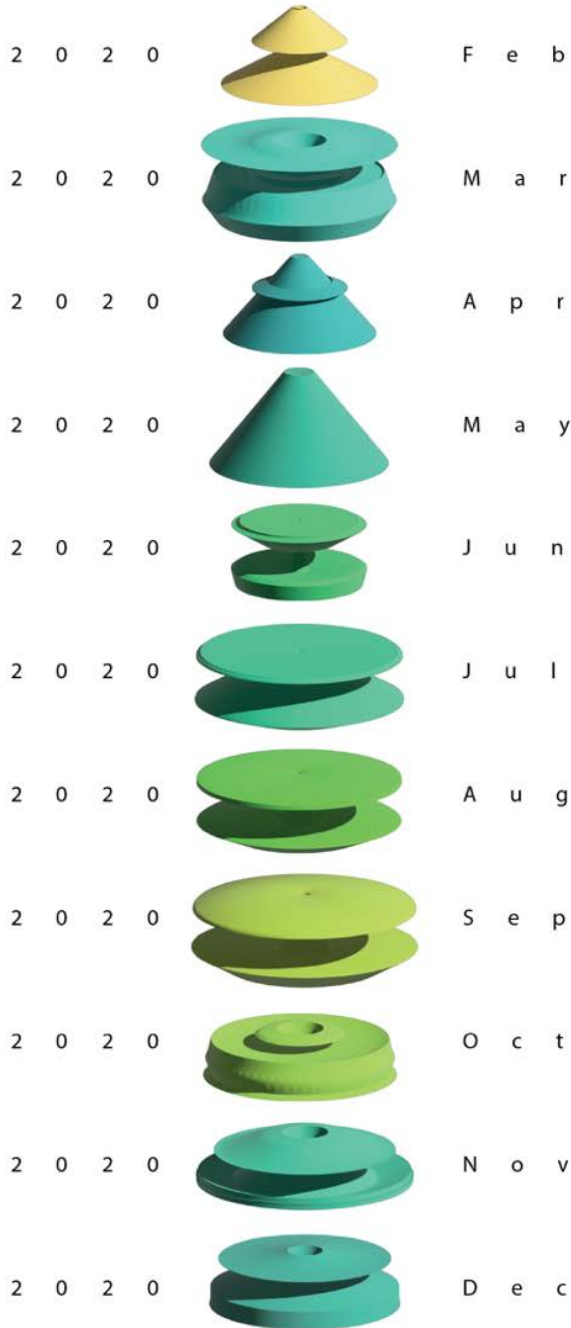


USA Jan:2022:



USA Jun:2022:





Regulating Observers: Visuality and the influence of scopic regimes on the experience of virtual space

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Abstract

This paper examines visuality and the 'scopic regimes' that influence how we experience digital spaces such as those offered by 'Virtual Reality' and 'Augmented Reality'. These 'regimes' are socially constructed ways of seeing which lie outside the mechanics of vision and affect not only what we see but also how we understand our relationship with visual media.

This paper considers the particular influence of the camera and how alternative conceptual models might offer a different approach to creating experiences of virtual space. This includes the ancient 'extramissionist' understanding of vision and 'emptiness'.

1. Introduction

In the influential collection of essays 'Vision and Visuality', Hal Foster and

others describe how 'visuality', distinct from the mechanics of vision, has shaped not only how we see but how we are made or allowed to see [1]. Certain conventions and devices, sometimes referred to as 'scopic regimes' [2] or 'perceptual schemas' [3], shape how we receive and understand media. Perhaps among the most well known and widely critiqued of these 'schemas' is perspective. While often seen as enabling an objective depiction of reality, Panofsky and others have shown how perspective is simply one 'reality effect', and that far from being definitive, several models of perspective exist [3]. Norman Bryson likens the role of visuality to a screen inserted between the retina and world consisting of "all the multiple discourses on vision built into the social arena" [4, p92]. This paper will look at how some of these 'scopic regimes' may regulate our experiences of virtual spaces such as those found in Virtual Reality (VR) and Augmented Reality (AR).

Although there are many influences on the development and experiencing of VR and AR, including references to prior media, this paper will examine the influence of the camera and lens media. This includes the camera as a metaphor, the related concept of the 'viewer/camera' and the potentially constraining nature of Flusser's photographic 'gesture'. The camera is chosen not only for its widespread

occurrence but as it can be seen to influence both the making and reception of virtual spaces and experiences.

Not all VR aims to create lifelike representations of the 'real world' or employ lens-based approaches. This paper will not aim to address how experiences can be made more 'real' or 'immersive'. It is not intended to offer a comprehensive survey of work in this area. Nor does it suggest that the camera is the only influence on the way virtual experiences are made and experienced. Instead, it uses the camera's influence as a way of thinking about other models and metaphors and what they might offer.

A range of terms and acronyms have emerged to describe virtual spaces and technologies including VR and A R. Terms such as Mixed Reality and XR are sometimes used as umbrella terms. They are also used to describe hybrid and complex combinations of VR, AR and other elements such as live performance and installation. Slippages between these different categories often occur, especially where they are employed as marketing tools. Here the abbreviations of VR, AR and XR are suggestive of a technological avant-garde, frequently used alongside terms such as 'immersive', 'interactive' and 'experience'. Such slippages are unhelpful as they imply a particular experience and draw attention away from more meaningful consideration of the qualities of the experience. The common term is generally 'reality'. This paper will not hope to address what constitutes 'reality' or the 'real'. However, what the term reality does suggest is an apparent link to previous media and 'reality effects'.

2. VR as a Continuation of Reality Effects

It would be easy to see VR as a continuation of several technologies used to capture and depict reality. Such a lineage might include the use of perspective in painting, photography, cinema, television and so on. Jonathan Crary notes how a continuity is often traced in which "Renaissance perspective and photography are part of the same quest for a fully objective equivalent of 'natural vision'" and in which the camera obscura and cinema are seen as "enduring apparatus of power" that continue to "define and regulate the status of the observer" [5, p30].

Each 'new' media seemingly fixes an imperfection in what came before through a process of remediation that brings us closer to the 'transparent immediacy' of pure and unmediated reception [6]. While clearly an oversimplification, the links to prior media and particularly lens-based media are regularly noted. Histories of the development of VR typically include reference to the panorama, stereograph and photographic camera [7], while histories of photography and cinema typically begin with the camera obscura [8, p26].

As Crary points out, rather than there being a continuous link between the camera obscura and later lens media such as photography and cinema, new understandings of the mechanics of vision in the 18th and 19th century dismantled the camera obscura as a model for our understanding of vision. While the camera obscura provided a model for accessing an 'objective truth', key to undoing the model was an

acceptance of our ability to misperceive [5, p39]. Cray points to the example of experiments which showed how electricity applied to the optic nerve could produce the experience of light [5, p39]. Nevertheless, an assumed connection between the camera obscura, photography and cinema persists based largely on certain formal qualities [8].

Not all VR, AR or virtual experiences aim to faithfully reproduce the 'real' world. What is useful to note is the connection to other lens media and to consider what these media bring with them, including assumptions about things such as image quality and fidelity. Much time and effort are given to refining VR technology, correcting perceived flaws. A typical research paper from this area describes how "In a perfect virtual world, each eye would be presented with exactly the visual geometry that it would be exposed to when viewing a real scene" [9]. What this seems to suggest is that there is a perfect 'real scene' that can be worked towards. This brings with it a danger that we assume all issues can be resolved technologically, through greater resolutions, faster refresh rates and correcting perceived imperfections. As Baudry and Williams note, imperfections and limitations such as 'depth of field' imply a particular conception of reality in the first place [10]. The idea that reality can be perfectly and definitively represented is far closer to the camera obscura model than later understandings of vision.

It is important to note that lens media are not the only influence on the development of VR and virtual experiences. The immersive theatre experience 'Draw me close' by the National Theatre in the UK is an example that combines elements of theatre,

drawing and animation [11]. It creates a complex and compelling hybrid that makes significant use of haptic and tactile feedback. Haptic and other sensory feedback are not considered here. However, as this example shows, other models and media disciplines can and do inform practice in this area.

3.The Scientific Character of VR

If the link between the camera obscura and VR may be largely superficial, what they do seem to share is their scientific flavour.

Michael Punt has noted the relationship between science, technology and early cinema in describing the technological imaginary of early cinema [12]. As an apparent descendant of cinema, VR has a similar character and its own technological imaginary. I have previously written about the influence of computational bias on our experiences of media [13], a subject that has been widely noted by James Bridle among others [14]. This includes how we are inclined to accept 'auto focus' and 'colour correction' for their convenience, as well as our privileging of algorithmic judgement over our own. As computational media VR and AR are framed by this wider context. However, they also have a particular character as an optical technology which may have its own implications for their visuality.

In reflecting on the cinematic apparatus, Baudry and Williams ask: "Does the technical nature of optical instruments, directly attached to scientific practice, serve to conceal not only their use in ideological products but also the ideological effects which they may

provoke themselves?” [10, p40], adding, “Their scientific base assures them a sort of neutrality and avoids their being questioned” [10, p40]. Arguably the scientific and technological character of VR and AR, seen in the way that such experiences are marketed, may have a similar effect. The Saatchi Gallery website describes how in the hugely successful immersive experience ‘We Live in an Ocean of Air’ “cutting-edge technology illuminates the invisible- but fundamental- connections between human and natural worlds” [15]. Meanwhile ‘Draw me close’ is described as “Weaving theatrical storytelling with cutting-edge technology” [11]. The link between ‘cutting-edge technology’ and new or extended ways of seeing seems clear. To what extent are we prepared to defer our judgement about how these experiences are constructed in the same way that we may defer judgement to other computational assistants such as auto focus?

Optics and scientific understanding of how the eye works is clearly of benefit to creating virtual spaces and experiences. Textbooks such as ‘Practical Augmented Reality’ often include chapters on optics and the working of the eye [16]. However, this scientific explanation of vision alone cannot account for the visuality of the experience of seeing. Perhaps because of the scientific and technological character of the processes involved, assumptions are made about the objectivity of the experiences offered and their ability to replicate how we see. A mistaken assumption that we see like a camera, or perhaps that the camera sees like us.

4. The Viewer/Camera

Cameras are involved in many aspects of

making virtual spaces, from photogrammetry used to capture and create 3D models, to the cameras on devices that enable AR. Meanwhile virtual cameras can be found in many of the software tools used. The documentation for the widely used game engine Unity describes how: “cameras are your eyes into an interactive experience” [17]. The concept of the virtual camera is an important one in creating virtual 3D environments but also brings with it and implies a certain visuality. It blurs the distinction between the camera and the viewer creating a new entity, the ‘viewer/camera’.

In many software tools virtual cameras are positioned and controlled to provide a viewpoint, or as the Unity quote suggests, a window or portal through which the viewer can look onto the created space. The intertwining of camera and viewer often occurs through an intricate nesting of objects and components. Complex hybrids of what are referred to as ‘actors’, ‘avatars’ and ‘cameras’ create an interlacing of the viewer, camera and navigation controls. These allow for the kind of first person or POV experiences with which we are familiar.

These are all clearly needed for the creation and functioning of certain types of experience. However, they also imply a particular way of thinking about the viewer and is far more constrained than the illusion of autonomy that they create within the experience. The 360-degree field of view seems to break from the constraints of the camera or cinema frame and allow the viewer to select their viewpoint. However, this is an idealised or intended view sometimes referred to or defined by parameters such as ‘targetview’.

This borrowing of concepts is an example of the encoding of existing tools described by Lev Manovich's computer as 'metamedium' [18]. Understood this way, game engines such as Unity and Unreal incorporate earlier mediums including, animation, cinematography, typography and photography bringing with them tools, workflows and concepts. Although as Manovich notes, as well as incorporating and digitising existing media and processes, the 'metamedium' can create new hybrid forms. The 'viewer/camera' could be seen as one such hybrid, albeit one that is often overlooked by its apparent familiarity.

The 'viewer/camera' is not only found in software tools. The concept of the 'viewer/camera' is used to describe and plan the production of Cinematic Virtual Reality (CVR) experiences [19]. This model places the viewer at the centre within the 'frame', the director arranging the scene around them.

Cinema is often described as a passive experience as the audience submit to the images which provide them with a 'God's eye view' that they cannot themselves control. CVR seemingly offers a more active role by allowing the viewer to look around and control what they see, but at the expense of the God's eye view since they may look away and miss things [19].

Viewing a film involves drawing on a learnt understanding of the grammar of film, allowing us to turn the cuts and camera movements into a unified experience [19]. The challenge for the makers of CVR is to develop new grammars and techniques to guide the viewers' attention. This raises the question of how the viewer understands their role and how learnt grammars

inform the experience. Turning our head in the 360 environment when understood as a cinematic experience may lead the viewer to search for the 'correct' or significant shot. It has turned us, if not into a director, then perhaps into a cinematographer. The viewer becomes a camera operator.

5. Seeing Like a Camera

Where the 'viewer/camera' is often found in the enclosed experiences of VR, AR employs the camera in a different way and more commonly sits between the viewer and the virtual experience. While technologies such as the HoloLens or Google Glass may promise their own form of the 'viewer/camera', AR is typically experienced using a camera phone or other handheld device.

The Google AR website describes how AR lets you "experience digital content in the same way you experience the world. It lets you search things visually simply by pointing your camera at them" [20]. Here we can see a tacit assumption that to experience the world is to do so through the camera, or at least that to experience through the camera is normal. Given the ubiquity of cameras and camera phones it is easy to imagine how we might be allowing the camera to mediate our experiences. The camera phone is used to augment our memories, to record our existence in the world and share it. It is important to note that these are networked devices and so the images that we create and receive are understood as part of a network of images [21]. AR appears to offer us the ability to extend our experience, summoning from the cloud virtual objects and manifesting them. In this way seeing through a camera phone is not a discreet experience between subject and object

but understood as entering into a shared digital space. However, this is also the logic of the camera, framing and extending its logic into real space.

In the software tools used to create VR and AR experiences, the virtual camera is typically positioned within a grid space and coordinate system. This regularly divided and seemingly infinite space has its own visuality connected to that of perspective techniques. The grid space is a dominant schema that occurs not just in 3D game engines and 3D modelling software such as Blender but has extended even to tools more associated with 2D imagery such as Photoshop. Lev Manovich in describing the 'automation of sight' and 'computer vision', refers to the 'perspectival machines' and 'geometry engines' of computational media [22]. Meanwhile, Damjan Jovanovic refers to the 'ground grid', marking out a uniform grid space, homogenising space and suggesting a certain 'total visual empowerment' [23]. These grid spaces are empowering due to their suggestion of limitless and granular control. However, they also constrain, relying on a single viewpoint and typically requiring us to think according to the logic of the grid space.

To understand the virtual object inserted into our space is to understand our surroundings according to the regulating grid space projected out into the world. AR experiences will often begin with a calibration process in which the grid space of the AR world is mapped onto and aligned with the space the viewer occupies (figure 1). Rather than the viewer being able to determine exactly where a virtual object can be placed, it is the device that has the final say on what is acceptable.

To understand the tension between the empowerment of AR and the control asserted by the camera through the grid space we could turn to Flusser's description of the 'gesture' made with the camera 'apparatus' [24, p198]. For Flusser the photographic gesture sees us search for a viewpoint through the camera view finder. This seemingly offers limitless possibilities but, Flusser argues, actually takes place within the "possibilities offered by the apparatus" [24]. When viewed this way, AR requires and is limited by the projection of the grid space reducing our understanding of the world to one of flat planes.

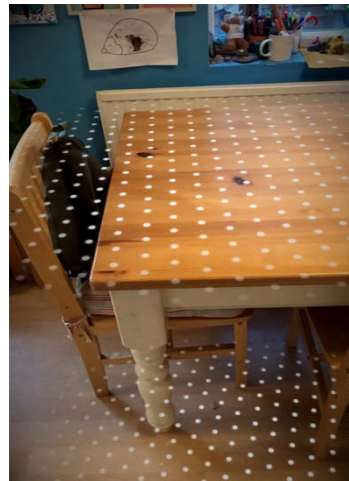


Figure 1. Screenshot of AR app calibration

It is interesting to note that the patents for AR technologies seem to show a far more active and controlling role than Flusser's gesture. The technical drawings submitted in support of patent applications for VR and AR technologies such as those shown in figure 2, show the eyes of the user connected to the proposed device or technology by straight lines as though they are projecting their will into reality. The patents aim to show the need for such a

technology rooted in an active human intention. As Baudry and Willams wrote of the cinematic apparatus, an extension seemingly “grafted on to replace his own defective ones” [10, p46]. On the one hand we have the technological imaginary of humans commanding these technologies as extensions of ourselves. On the other we have Flusser’s warning that we may mistake the limits of the apparatus as the limits of possibility.

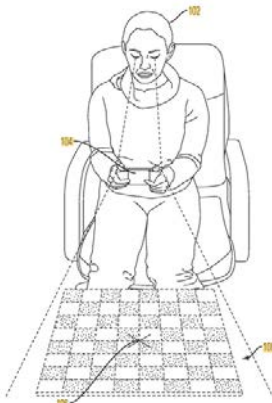


FIG. 2

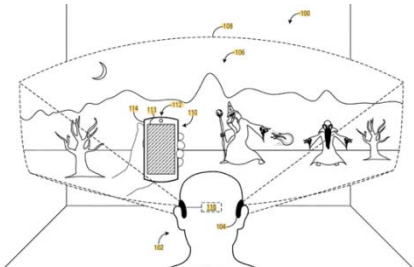


Figure 2. Images from patent applications for VR and AR technologies

The lines between the user’s eyes and devices the patents show could also be interpreted as intention, an important aspect of vision that more scientific and technological explanations may overlook. Iain McGilchrist notes the importance of intention for vision and how this changes the way that we see, what we see and how we understand seeing arguing: “attention is modified by the intention that

lies behind it” [25, p169]. In dismissing the camera metaphor for vision, McGilchrist argues “we never just ‘see’ something in the sense that a photographic plate receives rays of light. In the real world we bring a lot of ourselves to the party” [25, p165].

This would seem to reinforce the need to consider visibility and the contexts brought to the experience. However, the question remains, to what extent is the intention handed to us and shaped by notions of technology, relationships with the camera and understandings of prior media?

6. Extramissionist Drawing

Considering these issues and debates led to the question: What are the alternatives to some of the more prevalent metaphors and scopic regimes?

An alternative understanding of vision that seems to resonate with a more active and interpretive seeing can be found in the ancient extramissionist theories of sight. Extramissionist explanations of vision describe rays of light emanating from the eye and landing on the objects we see [26]. Thinking about light ‘emanating from the eyes’ rather than simply falling into them suggests a different role for the viewer. The rays might be imagined in much the same way as the lines that appear in the patent diagrams, suggestive of the intentions and will of the viewer. It also casts seeing as an act of discovery and interpretation. McGilchrist notes Plato’s description of a stream of gentle light from within merging with the light from objects to form one body [25]. Meanwhile Bryson describes how the signifier operates on light and yet has no light of

itself only “the light it borrows from my eye” [4, p91]. While bearing no relationship to the mechanics of vision, it may be a metaphor that better describes how it feels to see.

This understanding of seeing as a tactile sensory experience also resonates with descriptions of the haptic qualities of drawing. The inherently ambiguous and felt nature of drawing offers another way of exploring virtual space, and one that may bear closer relation to our actual experience of seeing. Nicolas Mirzoeff describes seeing as more like a rapidly drawn sketch than a photograph and how certain effects in painting such as ‘papillotage’ or ‘blinking’ accepted the constructed nature of sight including the role of eye movement [27]. Drawn virtual spaces already exist and can be seen to successfully exploit these qualities, including the previously mentioned ‘Draw Me Close’.

To explore how an extramissionist model might be applied, a set up was devised to produce ‘drawings’ of spaces and objects using the ‘emitted light’ of a depth camera. This employed a depth camera, such as the RealSense or Kinect, and custom code written using Processing. It is interesting to note that depth cameras such as the RealSense and other 3D scanning tools send out their own rays of light, albeit infrared light, in order to measure depth.

By holding the depth camera and moving it through space and around objects, depth data was captured and turned into a motion sequence that could be viewed in 2D or VR. Rather than capturing all the depth data, only a focused section was used. This created a point of focus that could be traced over the environment or objects, synonymous to the tracing of

light from the eye. Multiple depth cameras could be used simultaneously in an attempt to move away from the notion of a single viewpoint. The depth threshold and the limits of the hardware’s capabilities were pushed such that it created anomalies and visual artefacts that could be considered as errors or imperfections (figure 3). Parallels might be drawn here with the ‘papillotage’ effect, mimicking, or at least reflecting the mechanic imperfection of sight.

These ‘extramissionist drawings’ are intended to be records of seeing. They capture a process which combines the framing action of the camera, with a tactile notion of sight and the observation and attention of drawing. They aim to show that the capturing of space does not need to adhere to the apparently ‘objective’ logic of the camera, their constructed nature being very apparent.

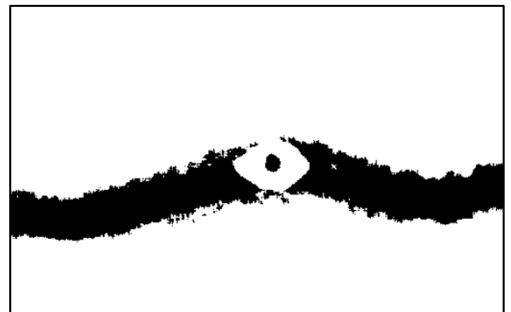


Figure 3. Screenshots of an ‘Extramissionist Drawing’ of an oil lamp

7. Emptiness and Immeasurable Space

Drawing at its simplest might be defined as a mark on a ground [28]. To this end a white background was used to provide a contrast to the 'marks' produced by the 'drawing' process. However, this seemingly 'empty' space also suggests an alternative to the constraints and predictability of the 'grid space'.

Norman Bryson describes how Keiji Nishitani's critique of the centring of the viewer found in Lacan and Sartre, put forward the concept of 'emptiness' [4]. This countered the framing process commonly found in painting and photography and which resonates with many forms of VR and AR. Bryson describes how "only that which appears within the framing apparatus – perspective, picture frame, camera – exists; the viewer on one side, the subject on the other" [4, p100].

Nishitani's approach is "to dissolve the apparatus of framing" [4, p100]. In doing so "The viewer is pulled away from the aperture of the viewfinder or lens and redefined as radically dis-framed." [4, p100]. As an example, Bryson refers to the 'Flung Ink' drawings of Sesshū Tōyō (figure 4). The cast ink creates forms that float on a "field of nihility or emptiness" breaking out of the tunnel vision that fixes object and subject [4, p95]. The rapidity and ambiguity of the marks deny the 'framework of control' that more regular marks might suggest.



Figure 4. *Haboku-Sansui* (1495) by Sesshū Tōyō (Wikimedia)

Dissolving the frame may seem to be equivalent to VR's removal of the screen in favour of viewer control and choice. However, this would overlook the centred nature of the viewer and the 'viewer/camera' metaphor, tethered to a subject. Far from breaking free from the frame, the VR and AR camera operator is in a constant act of framing.

Rather than using the grid space to construct a total and apparently full or continuous visual scene, emptiness can allow for a more ambiguous space. Bryson describes how when grids are absent "space itself becomes immeasurable" [29, p43].

An immeasurable space runs counter to the regular and regulated spaces of VR that rely on a quantification of space to be rendered. It draws attention to the mutability of our perception of space. A similar effect can be seen in the example of the Roman painted interiors such as the Black Room from Boscotrecase which play with the "ontological thresholds" between the represented and

reality [29]. These murals set hints of architectural and figurative elements on a field of black. The effect is to cause the eye to “move from the impalpable and insubstantial blackness [...] to images set at some indeterminate distance within it” [29, p43]. Such ‘fictive spaces’ can create a sense of limitless space precisely because of the removal of scale [29].

8. Conclusion

The technological nature of virtual experiences can overshadow the consideration of other qualities. While undoubtedly capable of offering radically new experiences, they inevitably draw on conceptual models and ways of working received from prior media. These shape both the making and the reception.

The approach outlined here is not intended as a replacement for the dominant ‘perceptual schemas’ or ‘scopic regimes’. Instead, it aims to open up discussion about what approaches might be developed at a time when the new languages and grammars of VR and AR are still being negotiated. The breadth of work in the field suggests there cannot be a unified approach. As a result, it pays to be aware of the options available rather than risk defaulting to existing approaches and allowing the audience to do the same. New possibilities will be created by looking beyond the most obvious and established models and metaphors. Only this way will it be possible to take full advantage of the ‘metamedium’ and create new hybrids and new ways we are ‘allowed’ to see.

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The Black Hole at the Centre of this Orb is a Rhombic Dodecahedron

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Abstract

I am exploring the symmetry of the rhombic dodecahedron in a way that produces a steady stream of visual extravaganzas. In my video with the same title as this paper (link below) I dynamically remove & replace colour on a stationary rhombic dodecahedral 'Orb'.

At GA 2022 XXV I am presenting a further eight clips of the rhombic dodecahedron as a *void*, a void constrained by the symmetric 'cuts' that separate the rhombic dodecahedron from its circumsphere.



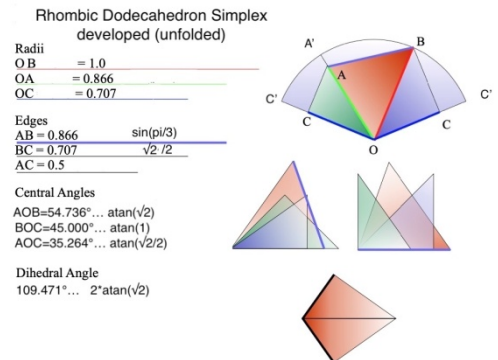
Mamma mia! I just broke my rhombic dodecahedron!

Just to be perfectly clear the rhombic dodecahedron in question is the Catalan solid that is the dual of the Archimedean cuboctahedron. It is an all space filler.[3]

1. Making the Cuts

A rhombic dodecahedron has four axes of symmetry. The three it shares with the octahedron provide the cuts that produce the simplexes that make an orb that I describe below. The fourth axis is a 2 fold symmetry aligned to opposite mid-edges.

Before I do any shading in my virtual world I construct a collection of surfaces by slicing the rhombic dodecahedron with octahedral symmetry planes into 48 pieces of equal volume; 2 sets of 24 irregular tetrahedra with mirror symmetry (enantiomorph simplexes) with surfaces labeled from the net drawing below: Face ABC, cross sections: Hypotenuse AOB,



Altitude AOC, Base BOC.

The rhombic dodecahedron's circumsphere can also be cut by these same planes producing 48 '*spherical*' irregular tetrahedra, (*spherical enantiomorph simplexes*): spherical S-Face A'BC', cross sections: S-Hypotenuse A'OB, S-Altitude A'OC', S-Base BOC'.

These 48 spherical simplexes are common to polyhedra with octahedral symmetries.

A spherical simplex minus a polyhedral simplex produces a *lens* unique to the polyhedron under examination.

In the octahedral family of polyhedra 48 lenses construct an O-orb. 24 lenses construct a T-orb for tetrahedral polyhedra and 120 lenses make an I-orb for icosahedral solids.

The rhombic dodecahedral lens contains five surfaces. Imagine, while referring to the diagram above, folding a cut out of the diagram along its radial lines to create surfaces in 3D: a triangular segment of a unit sphere (A'BC'), a triangle (ABC) that is 1/4 of a rhombic dodecahedral face and three chords (C'A'AC, A'BA, BC'C).

In composite assemblies left & right chords are shared by adjacent lenses. They are identical except for the direction of their surface normal vector. For these animations with the same display parameters as in 'The Black Hole...', experiments shading pairs of chords produced a slight brightening. Therefore in these animations I have reduced chord surface sets from 48 to 24 each.

The animation "The Black Hole..." with YouTube link below, is a shading of all 240 surfaces of the rhombic dodecahedral orb (5x48 surfaces). It was the first animation in this series that asks the question, "How is it possible that these observations, which seem so

different, are actually shadings of a singularity, the rhombic dodecahedron?"

The animations I am presenting at GA 2022 XXV do not shade surface ABC or the redundant chords. This 'no-face' version reduces surface count and speeds shading. It simplifies the scene and to my eye there is less visual noise.

In the animation "The Black Hole ..." the camera angle is aligned with the rhombic dodecahedron's 3-fold axis corresponding to the octahedron's mid-face axis of symmetry.

These new recordings are seen along the 4 axes of symmetry of the rhombic dodecahedron both from within and from without: concave and convex.

2. In Practise

These animations use my algorithm, the Rotating Transparency Transform, or RTT, for evoking a sense of *motion*. Motion that resembles that of a kaleidoscope.

I suspect the resemblance arises because this rhombic dodecahedron is constructed from a set of simplexes that are themselves kaleidoscopes; i.e. dihedral kaleidoscopes. [1]

Instead of looking into a kaleidoscope I am looking **into and through** a *set of 48 kaleidoscopes* from each of the 4 convex viewpoints.

For the concave shadings I am looking through 24 kaleidoscopes from inside at viewpoint (0,0,0) with single digit camera lens length, looking outward along the 4 symmetry axes.

In the "Black Hole..." animation a virtual camera recorded a series of 2D images. Images of what at first glance are merely discs. Images that were recorded in *Parallel* view. There is no parallax; no software tricks to make you think you are seeing a solid object. 3D structure must

be inferred over time. Inferred by observing dynamic 2D patterns of red and black that synchronize in the viewer's brain across time to hint at structure.

In the 3D modelling software Rhinoceros I select surfaces from a rhombic dodecahedron constructed of simplexes. I then iterate a rotation of a texture map in 0.1° increments. The texture consists of a single transparency derived from the Mandelbrot set. A *ViewCaptureToFile* command captures the rotational change for each of 3,600 frames. These combine to create an animation of length 2'30" at 24 fps.

In video post production clip duration can be adjusted. Titles, credits and audio can be added, as is the case in:

[The Black Hole at the Centre of this Orb is a Rhombic Dodecahedron](#)

3. Eight Orb recordings later.

I have recorded for GA 2022 XXV, for posterity, eight more visualizations in *parallel* view of the rhombic dodecahedron's domain. I have assigned the same rotating transparency [2] to select orb surfaces. Camera angles are selected from symmetry axes.

4. Viewers of the Orb

A new set of choices present themselves when I consider presentation. The raw footage was planned for a duration of 2'30" per clip at 24 fps. 8 clips makes for 20 minutes of viewing time. A lot to ask of an audience.

Each clip will loop seamlessly.

Adding titles disrupts the looping feature of the art. Linking clips together also disrupts the looping behaviour.

For presentation at the Generative Art Conference I have combined 2 sets of

four clips, forgoing loops, at 2x & 4x speed.

Adding a sound track has become *de rigueur* for visualizations such as these. A score designed to loop with the visuals would perhaps deepen the experience. My efforts at guitar noodling are not sufficiently nuanced to burden an audience's ear for 20 minutes. What would surely feel like an eternity?

Perhaps readings by James Earl Jones, from an obscure tome, could accompany these pixel extravaganzas? A synergy of senses to hold a viewer entranced for the duration. May I suggest my poems, from my romantic youth? "Odes" voiced by *Prostetnic Vogon Jeltz!* [4].

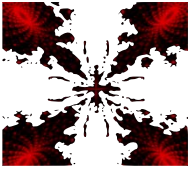
To collectivize my art, to reach more than one viewer at a time, I see a room with eight screens looping continuously. Audience members are encouraged to liaise with control surfaces to alter time, chroma and Ken Burns effects; to create a unique audience-engaged light show.

Of course, haute couture fashion houses attend the event ready to sign license agreements for use of selected patterns in their new spring line-ups. They provide complementary wine that flows! Relationships blossom.

I see a meta-verse installation of Horta Eggs [5] (fictional silicon based life forms) that when your avatar picks it up for examination, it begins to play an animation when a coded analog of: pitch, roll & yaw, is properly aligned to the optic nerves of one's avatar in the 'verse.

I see seniors' homes change the channel from *info-tainment news* to looping mandalas. Blood pressure medication use is reduced. (prediction not fact)

I see a glass bead game. A block chain.



5. Conclusion

Herein may we find beauty? Observe nature in a new way? Or just revel in the light!

For purposes of GA 2022 XXV I am providing links to 2 new composite animations.

The first animation is scaled in time to approximately four and a half minutes in length. This allows me to add my cover version of the classic John Cage [6] track, 4'33" to run as background audio. The clip runs at 216% speed; 68 seconds of observation per axis.

[Rhombic Dodecahedra in a Rotating Transparency Field, Convex](#)

The second animation is sped up in time by a factor of 4, providing approximately 30 seconds observation per axis. Caution! Speed may not be to your liking. A *'push me - pull you'* or a *'point in every direction is the same as no point at all'* effect is witnessed at high speed. Maybe your browser will let you slow it down.

[Rhombic Dodecahedra in a Rotating Transparency Field, Concave](#)

As a test audience of one, I actually prefer my slow 38 minute version of these clips. Yet for GA 2022 XXV I have *sacrificed my preference* for that of an audience that I imagine is *pressed for time*.

Each animation has its quirks.

For instance I can't explain the variation in the apparent radial or concentric motion except that it has something to do

with *'angle of incidence'*.

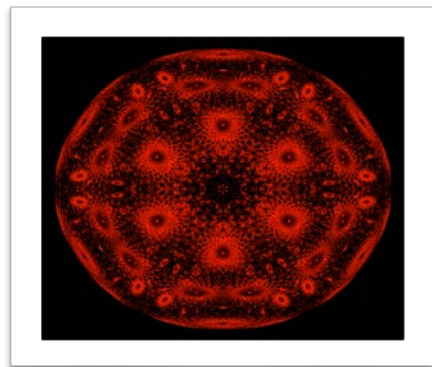
And why do these motions seem to be occurring simultaneously? "Oh. I get it! I am seeing the dark side of the moon, too!"

One quirk, did you see it? I confess is a periodic brightening, a slow strobe. Turns out my early programs' initial conditions duplicated the first 2 frames in each of twelve, 300 frame recording sessions, required to capture the full cycle.

Do I fix it? or do I feature it?

5. References

1. "27 Blue Dihedral Kaleidoscopes", Curtis L Palmer. <https://youtu.be/e7f2CqjTL4Q>
2. "Mandelbrot Set-13-Julia Islands" (Created by [Wolfgang Beyer](#) with the program *Ultra Fractal 3*).
3. "Kepler and the Rhombic Dodecahedron", R. Cardil. <http://www.matematicasvisuales.com/english/index.html>
4. "Hitchhiker's Guide to the Galaxy" D. Adams 1978 BBC.
5. "The Devil in the Dark" Star Trek, 1967.
6. 4'33" John Cage. <https://youtu.be/JTEFKFiXSx4>



Practical Resources for Developing Idiosyncratic Generative Systems for Dance

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Abstract

Computer-based generative approaches possess a great creative potential in Contemporary Dance, in particular for artistic realisations that combine dance and technology. At the same time, the adoption and dissemination of generative approaches in dance is hampered by the fact that Dance and Technology is a small subfield within Contemporary Dance, with Generative Dance occupying an even smaller niche within this subfield. The work presented in this paper tries to ameliorate this situation by supporting artistic communities in Contemporary Dance and Generative Art with practical resources in the form of source code, dance data, educational

articles, and documentations of exemplary artistic realisations. This material is meant to motivate and facilitate the selection from and adoption of a wide range of computational techniques and their use as foundations for realising dance specific generative systems. These techniques include both computer simulations and machine learning models that have proven useful in the author's own collaborations with dancers and choreographers for translating embodied creation principles into generative procedures. With regards to the integration of generative systems into the creative process, the provided material differentiates itself from other existing tools and collections in that it supports artists in devising their own idiosyncratic generative systems instead of working with a readily available but inscrutable software. Accordingly, this material aligns with artistic approaches that attribute a central role to the ideation and development of a generative system within a creative process.

Keywords: Dance, Generative Art, Machine Learning, Creative Coding

1. Introduction

Computer-based Generative Art provides a fertile ground for artistic experimentation in Contemporary Dance. But the number of artists who are active in this field and the number of tools available to them is very small, especially when compared to other artistic domains such as music and fine arts.

This article hopes to increase the popularity of generative approaches in Contemporary Dance by contributing a set of tools that facilitate the development of generative systems. These tools take the form of programming libraries and source code examples. This form has been chosen to foster a creative approach in Contemporary Dance that is already embraced by many practitioners in Generative Art, that is to situate the development of generative systems at a core of creative practice.

The tools cover a broad range of generative techniques and include both simulation-based and data-driven methods. The tools are made available alongside educational material and artistic case studies. The educational material introduces not only the technical principles of each generative techniques but also provide context about embodied forms of creativity and the methods employed for bringing dance into digital form. The artistic case studies illustrate the adoption of the tools in collaborative creative productions, all of which have resulted in public performances.

The tools and the accompanying materials represent the main tangible outcomes of a two and half years long

fellowship during which the author has collaborated with dance scholars and practitioners. These collaborations served the purpose of identifying principles of embodied creativity which can be adopted for the development of generative techniques.

2. Background

Computer-based generative approaches possess a niche status in Contemporary Dance. The cause for this are conceptual and practical issues that are inherited for the most part from the wider field of Dance and Technology. The background section briefly introduces some of the most prominent issues and provides an overview of existing tools that support generative approaches in Contemporary Dance.

2.1 Dance and Digital Technology

The relationship between dance and technology is the subject of several debates, some of which raise principled concerns. These concerns are based on fears that technology is dismissive of the human body [31], incompatible with the ephemeral characteristics of dance [15], and alienates dancers and audiences from the experiential and intellectual aspects of movement [38]. These fears are countered by opinions that technology opens up new avenues for understanding [15, 29], envisioning [34], and experiencing dance [26]. Other concerns deal with practical issues such as the removal of essential context in digital representations of dance [40], the blindness of sensing technology to nuanced and hidden aspects of dance [28], and the difficulty of formalizing dance as highly idiosyncratic creative practice [1, 41]. These concerns contrast with opinions that emphasise the

proximity between choreographic thinking and algorithmic approaches [21, 1, 32].

The author is convinced that generative approaches possess the potential to contribute to these debates in a practical and constructive manner. This is because practitioners in Generative Art possess the expertise to formalise creative processes and bring them into the computational domain while preserving their core idiosyncratic properties. This is also because generative systems can operate in a non-deterministic manner and produce results that are similarly variable and ephemeral as live performances. Finally, it is also because Generative Art often draws from sophisticated techniques for modeling biological, cognitive, and social principles and is thereby able to synthetically recreate both experiential and cultural aspects of bodily creativity.

2.2 Dance and Generative Tools

Most generative systems that have been developed for dance specifically cater to the creative approach of a single choreographer or dancer and are not intended to be used by other dance practitioners. The overview provided in this article focuses on the small number of generative systems that were developed with an application by the wider dance community in mind. A more exhaustive survey of generative systems that covers both idiosyncratic systems for individual dancers and more generic systems for a wider dance community has been previously published by the author [3].

2.2.1 Dance Instructions

Several systems have been developed for automatically creating instructions for human dancers.

The *Adaptive/Responsive Movement Approach (A/RMA)* is a generative tool for collaborative projects including dance and new media [30]. This system draws from system theory, computational programming protocols, and directed improvisation techniques. It provides a language for defining a trigger-based logic based on which dancers respond to the presence and activities of other dancers, audiences, and media on stage. The *A/RMA* systems is taught in workshops and can easily be adopted and modified by its users.

Terpsicode is a prototype programming language for live coding algorithms that generate choreographic patterns [35]. The language builds on top of a vocabulary for describing movement, timing, and phrasing. The generated choreographic patterns are shown to dancers as a succession of photographs of dance poses. The dancers are free to interpret these poses and explore different transitions between poses. While *Terpsicode* is restricted to pattern-based approaches, it can be combined with different vocabularies.

2.2.2 Creativity Support

Several systems have been developed to support the creative process of choreographers.

Scuddle serves as co-creative tool that assists choreographers in the discovery of novel body movements [18]. It employs a genetic algorithm to generate incomplete movement proposals as catalysts for ideation. The fitness function evaluates the proposals according to

body symmetry, position, and levels and favours contralateral movements and unstable levels. This system was evaluated as stand-alone software and its behaviour cannot be modified.

Cochoreo has been realised as submodule for the choreographic software *idanceForms*. It can be used to generate full body poses as key-frames on a choreographic timeline [19]. *Cochoreo* employs the same evaluations as part of its fitness function as *Scuddle*. But contrary to *Scuddle*, the user can change the contributions of the individual evaluations to the fitness value by weighting them differently.

Hsieh and Luciani have developed a tool for generating dance movements based on a physical simulation of energy propagation [27]. The tool is based on the assumption that choreographers think in terms of energy transmission instead of keyframes when designing dance movements on a computer. The tool employs the *Cordis-Anima* dynamics simulation to deconstruct a dancing body into a minimal set of interactions between masses. Following this approach, a basic set of dance verbs has been chosen and for each of them a minimal set of masses and the dynamics of energy propagation were defined. The tool can in principle be extended to simulate other types of dance movements.

The *Body-part Motion Synthesis System (BMSS)* allows users to synthesize and sequence body motions into short choreographies for a single dancer [36]. The system provides a co-creative workflow in which the user specifies a whole body motion and body part categories and the system determines suitable body part motions, timings, and

blendings with successive motions. The system provides some flexibility by varying the balance between manually and automatically generated motions.

The *chor-rnn* system creates synthetic motions for a single dancer [20]. The system employs an autoregressive neural network for pose sequence continuation that can be trained on motion capture data. After training, *chor-rnn* is able to generate novel choreographic material in the language and style of an individual choreographer. The authors of *chor-rnn* propose a creative workflow in which the system and a choreographer take turns and either continue each other's motion sequences or use them as inspiration. This system is released as open source code and can be retrained or modified.

Petee et al. have released several machine learning-based tools that are meant to augment a choreographer's workflow [29]. These tools include an autoencoder for poses, a variational autoencoder for pose sequences, and an autoregressive neural network for pose sequence continuation. These models can be trained on motion capture data of a single dancer. The authors discuss applications of these models for production, creation, introspection, and teaching. These systems are released as open source code and can be retrained and modified.

2.2.3 Interactive Media

Several systems have been developed for controlling and/or generating interactive media.

Among these, the *ViFlow* system is the only one that is specifically geared towards dance [16]. *ViFlow* employs a

particle simulation to generate interactive visuals for live performance. This system provides gestural controls for interacting during performance and also for authoring the simulation and visualisation. The authors claim that the system can be easily integrated into an embodied creation workflow and alleviates the need for dancers to collaborate with engineers.

Embodied forms of interacting with and authoring of digital media are also facilitated by several machine learning based tools such as Wekinator [23], ml.lib [17] and Marcelle [24]. Most example applications for these tools deal with the design of digital musical instruments [22]. Nevertheless, these tools can also be adopted for dance-specific purposes. The tools support a create workflow for designing gestural interfaces that exploit tacit and embodied knowledge about movement [25]. The tools offer different machine learning models that users can choose from, parametrise, and train. To foster iterative and explorative workflows, the models provided are simple enough to operate in real-time, handle low dimensional input and output data, and can be trained on very small datasets. These models cannot directly generate synthetic media but are instead used to establish mappings between interfaces and parameters for controlling an external media generation system. The flexibility of Marcelle exceeds that of Wekinator and ml.lib since it allows users to add models of their own.

The tools that have been developed by the author complement the generative tools listed above in that they cover a much broader range of generative techniques and are provided in the form

of programming libraries and source code examples instead of stand-alone applications. Accordingly, these tools are aimed at artists who are interested in developing their own generative systems and require a maximum amount of flexibility for this purpose.

3. Tools

The tools are provided in the form of open source libraries and source code examples for the two programming environments *openFrameworks*¹ and *PyTorch*². *openFrameworks* is a C++ programming environment for developing creative applications. *PyTorch* is a deep-learning framework that provides a Python and C++ interface. These environments have been chosen because *openFrameworks* is particularly popular in the creative coding community and *PyTorch* is frequently used by researchers for developing and sharing novel machine learning methods. Furthermore, models implemented in *PyTorch* can easily be exported and integrated into C++ code which makes this environment suitable for real-time and interactive applications. All tools are accessible via *GitHub* repositories.

3.1 Simulation-based Generative Tools

Several software libraries have been developed in the form of *addons* for *openFrameworks*. These libraries facilitate the development of simulation-based generative systems. Currently, libraries are provided for simulating mass-spring systems, articulated rigid bodies, and flocking behaviours.

3.1.1 Mass-Spring Systems

¹ openFrameworks: <https://openframeworks.cc/>

² PyTorch: <https://pytorch.org/>

The addon³ provides functionality to simulate mass-spring-damper systems. The simulation implements regular springs which exhibit a restitution force whenever they deviate from their rest lengths and in which damping forces oppose the velocities of mass-points. The simulation also implements directional springs which exhibit a restitution force whenever their relative directions with regards to a preceding spring deviates from their relative rest directions (fig. 1 top). The simulations also supports the applications of external forces to mass-points which can either be randomised or deterministic. For numerical integration, both Euler and Leapfrog integration schemes are provided. The simulation can be employed to construct mesh topologies in which mass-points are organised in lattices (fig. 1 middle) and cross-linked via multiple springs or to create branching topologies (fig. 1 bottom).

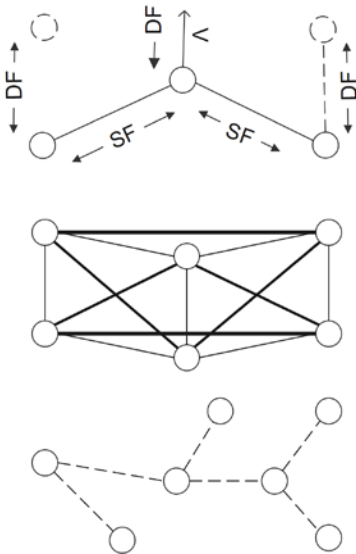


Figure 1: Mass-Spring Systems. In these graphical depictions, mass-points are shown as outlined circles, regular springs as solid lines, and directional springs as dashed lines. The figure at the top depicts the forces acting on mass-points. These forces are shown as solid arrows and are labeled as follows: SF stands for regular spring restitution force, DF stands for directional spring restitution force, DF stands for damping force. Velocity is shown as outlined arrow and abbreviated as V. The figure in the middle depicts mass-points and regular springs that are organised in a mesh topology. The figure at the bottom depicts mass-points and directional springs that are organised in a branching topology.

3.1.2 Articulated Rigid Bodies

The addon⁴ employs the Bullet rigid body dynamics engine on top of which it provides classes for importing, configuring, and actuating articulated morphologies. Morphologies consist of body parts which are connected to each other via joints (fig. 2). The body parts are rigid and can possess arbitrary shapes. The joints can either be passive or active. Active joints act operate in one of the following modes: as freely spinning motors, as servo motors that possess a target rotation, and as spring motors with stiffness and damping properties. Bodies can exhibit autonomous behaviours. Behaviours are routines that periodically change some of the physical properties of the body parts or joints that are assigned to them. These changes can

³ ofxDabSpring:
<https://github.coventry.ac.uk/ad5041/ofxDabSpring>

⁴ ofxDabPhysics:
<https://github.coventry.ac.uk/ad5041/ofxDabPhysics>

either be deterministic or random. Behaviours can also operate on joints or body parts that don't belong to only one body and thereby generate coordinated movements among several bodies.

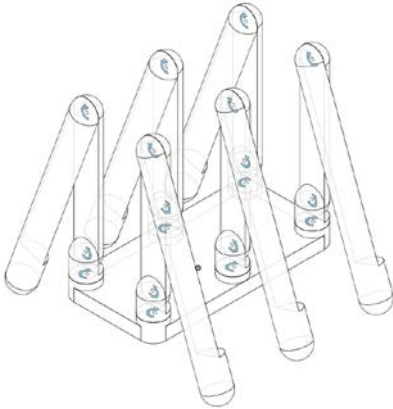


Figure 2: Articated Morphology. The graphical rendering depicts a morphology that consists of six legs which are attached to a base platform. Each leg possesses three joints that provide one rotational degree of freedom. In the rendering, body parts are shown as outlined shapes and rotational joints as curved arrows.

3.1.3 Flocking Behaviours

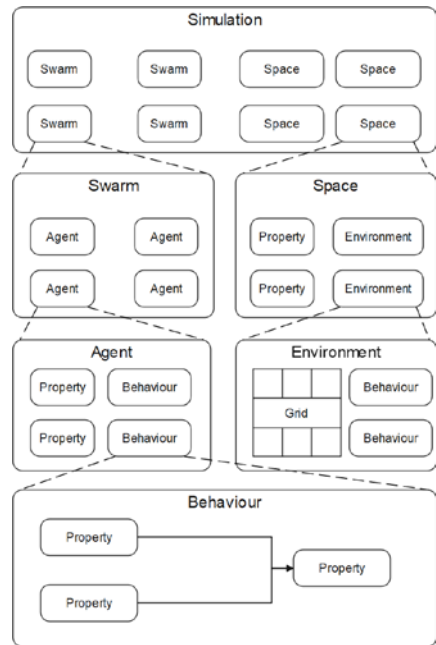


Figure 3: Flocking Behaviours. The schematic image displays the hierarchical organisation of the main elements that make up the simulation.

The addon⁵ provides functionality to simulate flocking behaviours. This simulation has originally been developed as generative mechanism for computer music [9, 8, 33, 6]. The simulation models the behaviours of agents that organise in single or multiple swarms (fig. 3). The agents possess properties. The properties can be assigned to spaces to calculate neighborhood relationships among them. Spaces can also possess spatially distributed properties which can change dynamically based on cellular automata rules. Both agents and spaces can possess behaviours which read and modify properties. The simulation is highly generic in that the number of

⁵ ofxDabFlock:

<https://github.coventry.ac.uk/ad5041/ofxDabFlock>

agents, swarms, and spaces, the type and dimensionality of properties, and the effects of behaviours can be chosen freely.

3.2 Machine-Learning based Generative Tools

Several generative models have been implemented for the *PyTorch* framework. The models include sequence continuation networks, generative adversarial networks, and adversarial autoencoders. All models are available online⁶. With the exception of sequence continuation networks, different versions of each model have been created for image, pose, and pose sequence data. The models are provided with example training data. In the case of images, data has been collected by searching the social media platform *Flickr*⁷ for photographs of dancers. In the case of poses and pose sequences, data has been obtained by conducting motion capture recordings of a professional dancer. The poses and pose sequences consist of joint orientations that are represented as unit quaternions.

3.2.1 Sequence Continuation

The sequence continuation networks are provided in two versions. Both versions are autoregressive, consist of a Long-Short Term Memory (LSTM) network, and take as input a sequence of poses for which they predict as output a potential sequence succession. The simpler version is deterministic and directly outputs a pose (fig. 4 top). The more complicated version is probabilistic

and passes the output from the LSTM into a mixture density network (MDN) (fig. 4 bottom). This network outputs for each pose dimension the mean, standard deviation, and weighting for several Normal distributions. An MDN decreases the risk that a predicted sequence continuation stagnates after a while.

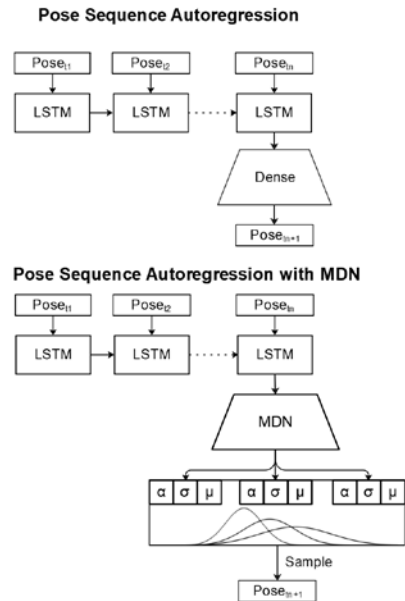


Figure 4: Autoregressive Models for Pose Sequence Continuation. The model depicted at the top is deterministic. The model depicted at the bottom is probabilistic. Following conventions, the LSTM network is shown unrolled in time with time running from left to right.

For both models, two different training schemes are available, one that always provides the correct pose as model input (Teacher Forcing) and one that occasionally provides the model's own output as input (Without Teacher Forcing). Without Teacher Forcing, the model becomes better at correcting its own errors during sequence continuation.

⁶ ML Models:

https://github.coventry.ac.uk/ad5041/PyTorch_ML_Tutorials

⁷ Flickr: <https://www.flickr.com/>

3.2.2 Generative Adversarial Networks

Three different Generative Adversarial Networks (GAN) are provided, one for poses (fig. 5 top left), one for pose sequences (fig. 5 bottom), and one for images (fig. 5 top right).

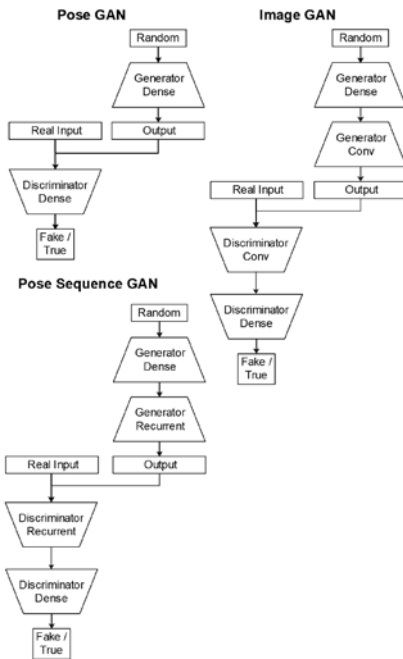


Figure 5: Generative Adversarial Networks. Shown are three networks: one for generating poses (top left), one for generating images (top right), and one for generating pose sequences (bottom). Each network consists of two models, a Generator which is shown on the right and a Discriminator which is shown on the left of each model.

Each GAN consists of two models, a Generator that takes as input a vector of random values and produces as output a data instance, and a Discriminator that takes as input a data instance and produces as output a binary value that classifies the instance as either real

(instance is from the dataset) or fake (instance is from the Generator). The models in the GAN that operates on poses consist of a multilayer perceptron (MLP) only. The two other GANs add to their models a network that is either convolutional for images or recurrent for pose sequences. During training, the two models compete with each other. The Generator tries to improve its capability to produce data instances that the Discriminator mistakenly categorises as real. The Discriminator tries to improve its capability to distinguish between real and fake data instances. After a successful training, the output of the Generator is indistinguishable from instances that stem from the dataset.

3.2.3 Adversarial Autoencoders

Three different Adversarial Autoencoders (AAE) are provided, one for poses (fig. 6 top left), one for pose sequences (fig. 6 bottom), and one for images (fig. 6 top right). An autoencoder is a model that operates as information bottleneck by encoding and mapping high-dimensional data instances into a low-dimensional latent-space. Mathematical operations can be conducted in latent-space and the result of these operations can be converted back through decoding into data instances.

AAEs adopt the use of a Discriminator from GANs. Here, the task of the Discriminator is to classify latent dimension vectors as real when following a true Normal distribution or fake when output by the Encoder-part of the autoencoder. Controlling the distribution of latent vectors ensures that the latent space is free of gaps and that distances within it represent a measure of similarity. This in turn guarantees that

arbitrarily chosen latent vectors can be converted by the Decoder into meaningful data instances. For all three AAE, the Discriminator model consists of an MLP only. In case of the AAE that operates on poses, the Encoder and Decoders also consist of MLPs only. In case of the other AAE, an additional network is added that is either convolutional in case of images or recurrent in case of pose sequences. During training, the autoencoder not only enters into an adversarial competition with the Discriminator but also tries to improve its capability to reconstruct instances of the training data.

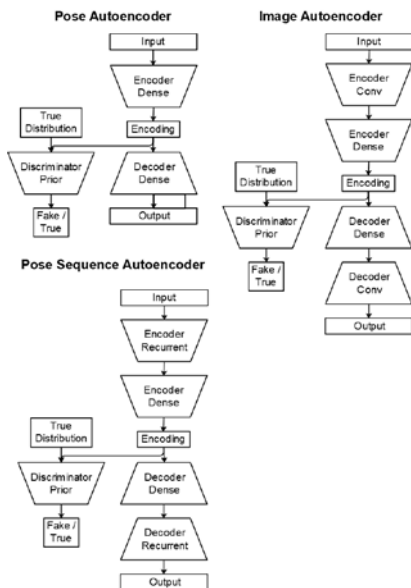


Figure 6: Adversarial Autoencoders. Shown are three autoencoders: one for generating poses (top left), one for generating images (top right), and one for generating pose sequences (bottom). Each autoencoder consists of three models, an Encoder which is shown on the top right, a Decoder which is shown on the bottom right, and a Discriminator which is shown on the left of each model.

4. Educational Material

The release of the tools is accompanied by an educational blog⁸. This blog provides a large number of articles that are meant to deepen and bring together an understanding for Contemporary Dance with skills in both simulation-based and data-driven forms of Generative Art. The topics covered by the articles include creative embodied practice, methods for digitising and analysing dance, generative methods for simulating dance, and machine learning models for synthesising dance movements. Also included are tutorials for all the tools that are described in this article. The blog not only helps with learning how to work with these tools but also situates the tools firmly in Contemporary Dance, either as a rich resource of inspiration for creating generative artworks, or as domain of application for Generative Art.

5. Artistic Case Studies

Most of the tools have emerged from or were employed for the development of generative systems used in artistic realisations. This article presents a selection of the most recent realisations.

5.1 Strings P

Strings P is an audio-visual concert [13] that involves three instruments: an acoustic violin, a synthetic acoustic instrument, and a synthetic visual instrument. These instruments are related to each other conceptually, technically, and aesthetically by sharing the same physical principle of a vibrating string [14]. In case of the synthetic

⁸ Educational Blog:

<https://wp.coventry.domains/e2edu/>

instruments, vibrating strings are simulated using mass-spring systems.

The generative system that controls sound synthesis simulates several one-dimensional arrays of interconnected springs. These arrays are sonified following a direct audification approach [37] by mapping the deflection of mass-points into amplitudes of a waveform.

The generative system that controls image synthesis simulates two-dimensional meshes of interconnected springs. These meshes are created dynamically from a live camera image by detecting salient image points and tessellating them into triangulated surfaces (fig. 7). The surfaces are visually rendered with a colouring that depends on the live camera image and an opacity that depends on the amplitude of the springs' oscillations.

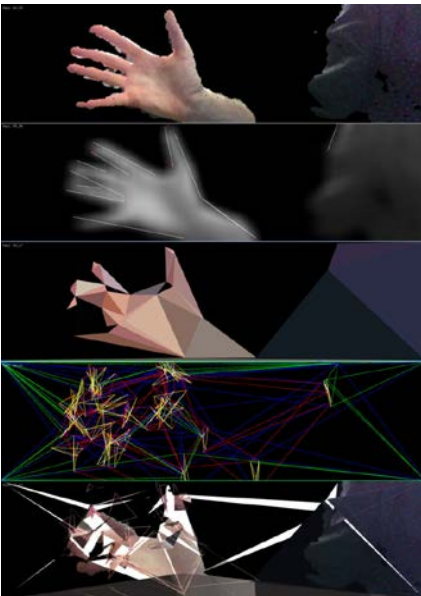


Figure 7: Conversion of a Camera Image into a Mass-Spring System. From top to

bottom: The camera image, salient contours and feature points in the camera image, Delaunay triangulation derived from feature points and coloured according to the camera image, a Mass-Spring System created from the triangulation, and the final visual rendering of the Mass-Spring System.

Interaction between the three instruments is based on acoustic resonance. The acoustic output of the violin is recorded by a microphone and its most prominent spectral peaks are identified. Based on the amplitude and frequency of these peaks, periodic motions are imposed on those simulated springs that possess a matching resonance frequency. The resonance frequency is derived from the rest lengths of the simulated springs.

This setup establishes a performance situation in which the violinist can exploit his familiarity and virtuosity with the acoustic instrument to simultaneously play two novel synthetic instruments (fig. 8). A video recording of the performance is available online⁹.

⁹ Strings P Performance Video: <https://youtu.be/eUwZuc2OxHs>



Figure 8: Still Image of a Video Recording of a Rehearsal.

5.2 Artificial Intimacy

Artificial Intimacy is an installation that creates a duet between a single human dancer and an artificial dancer. The human dancer acts as puppeteer who controls a single limb of the artificial dancer while its remaining limbs remain under the control of a machine learning model. The human dancer interacts with the artificial dancer by means of a wearable sensor that measures absolute orientation. The measured orientation is either translated into a target rotation for one of the artificial dancer's limbs or into a target position towards which the artificial dancer reaches with one of its limbs.

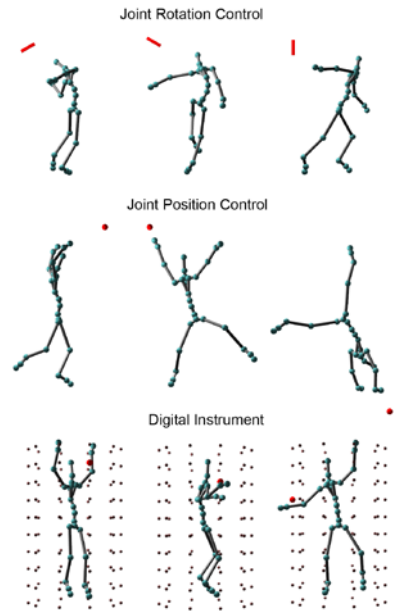


Figure 9: Machine Learning-based Artificial Dancer. The images on the top and middle row depict the artificial dancer responding to interactively controlled changes of its right shoulder rotation (top row) or the target position of its right hand (middle row). The bottom row depicts the artificial dancer surrounded by resonant filters depicted as small spheres.

The artificial dancer is based on a generative system named *Granular Dance*. This system combines an Adversarial Autoencoder trained on pose sequences with a mechanism to seamlessly concatenate multiple pose sequences [4]. For realising this installation, *Granular Dance* has been extended with two novel methods for interactively creating synthetic motions. These methods operate on the level of the motion itself rather than its encoding. The first method combines the control of the orientation of a joint with iterative

autoencoding [12] (fig. 9 top row). The second method combines the control of the target position of a joint with forward kinematics and the application of latent difference vectors [11] (fig. 9 middle row).

For visualisation, the Ray Marching method is employed to display the artificial dancer as smooth surface that varies between a humanoid and amorphous appearance (fig. 9). The artificial dancer is also displayed acoustically using a virtual musical instrument. This instrument simulates a vibrating surface by means of a bank of resonating filters. The filters are arranged cylindrically and surround the artificial dancer (fig. 9 bottom row). The instrument emits sounds when the artificial dancer approaches the filters.

Video recordings of a rehearsal are available online¹⁰.



Figure 10: Still Image of a Video Recording of a Dance Rehearsal.

5.3 Embodied Machine

¹⁰ Artificial Intimacy Rehearsal Video:
<https://vimeo.com/724839655>

Embodied Machine is a performance for a single human dancer and a stage that acts as an extension of the dancer's body or as an autonomous dance partner. At the core of *Embodied Machine* are movement qualities that have been developed by choreographer Muriel Romero. These qualities are used to establish a common ground between the human dancer, music, and light.

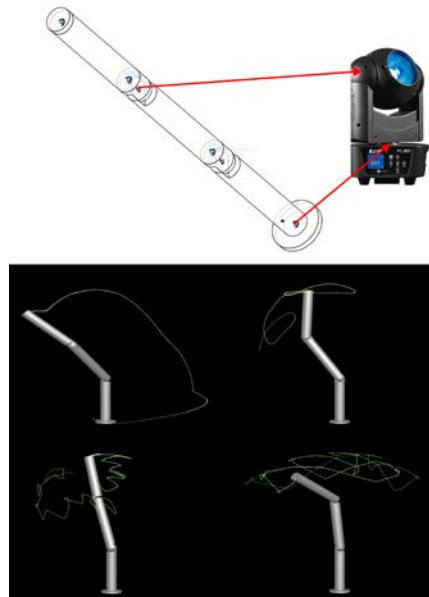


Figure 11: Simulated Articulated Bodies. The figure at the top depicts the mapping of joints between a simulated body and a robotic moving light. The figure at the bottom depicts a simulated body performing movements according to different movement qualities.

Several robotic moving lights have been used in the performance. These lights are endowed with the capability to execute autonomous movements that express specific movement qualities [5]. For this purpose, the robotic lights have been modelled and simulated as articulated rigid bodies (fig. 11 top). The

simulation has been extended with two behaviours. A behaviour named *Force Behaviour* generates forces that impact externally on body parts. A behaviour named *Rotation Behaviour* specifies target angles towards which body joints rotate to. By assigning body parts and joints to these behaviours, and by choosing appropriate settings for the parameters of the bodies and behaviours, the desired movement qualities could be imitated (fig. 11 bottom). These movement qualities were then transferred on the robotic lights by mapping the joint rotations from the simulated bodies on the robotic lights.



Figure 12: Still Image of a Video Recording of the Scene Progression.

The autonomous robotic lights were employed in two dance scenes. A scene named *Approximation* plays out as a series of duets between a human dancer and each robotic light. The dancer approaches one robotic light after the other. Once the dancer is sufficiently close to a robotic light, this light starts to emit light and chooses a movement quality according to which it behaves. In a scene named *Progression*, the robotic

lights follow their own choreography independently of the activities of the human dancer. The choreography progresses through several stages during which different movement qualities are combined or juxtaposed (fig. 12).

Video recordings of excerpts of the scenes *Approximation* and *Progression* are available online^{11 12}.

6. Discussion

The tools that have been introduced in this article form part of the author's attempt to foster and facilitate the exchange and collaboration between Generative Art and Contemporary Dance. The tools constitute the practical complement to the author's previously published taxonomy of generative approaches in dance [3].

The tools are unique with regards to the breath of generative methods they employ. Some the tools make use of simulation-based methods and others of data-driven methods. Each category of methods comes with their own benefits and drawback. Simulation-based methods usually excel at reproducing natural phenomena but struggle with capturing unique stylistic or expressive aspects. Data-driven methods possess the opposite properties.

In the following, the application potential of each method is briefly addressed. Simulations of mass-spring systems have been popular for a long time since

¹¹ Approximation Videos:

<https://youtu.be/6LYVv1aq5hQ>

<https://youtu.be/XBfkygb1c8>

¹² Progression Videos:

<https://youtu.be/bTh7102zfE>

<https://youtu.be/h5SkN97wiKc>

they are easy to implement, fast to compute, and can mimic a broad range of physical phenomena. Such phenomena include flexible surfaces such as textiles, vibrating bodies such as acoustic instruments, or elastic morphologies of plants or invertebrates. Simulations of the constrained dynamics of rigid bodies are widely employed in computer games for character and vehicle animation. In the context of dance, these simulations can be used for modelling the behaviour of artificial dancers. Since the simulated bodies don't necessarily have to be anthropomorphic, they can also be used to represent and control actuated machinery on stage. Simulations of flocking behaviours are among the most canonical forms of multi-agent systems. Originally, these simulations have been employed to model the coordinated movements of animals such as flocks of birds or schools of fish. But likely any form of coordinated spatial motion can be modelled with these simulations, regardless of whether it is of physical, biological, or speculative origin. Accordingly, these simulations offer great artistic flexibility for creating and controlling the spatial distribution of media and for designing interactions. Machine-learning models for sequence continuation have gained some prominence as generative tools for choreography. A model that has been trained on example movements of a specific dancer or choreographer can generate synthetic dance movements that mimic with a high degree of fidelity the stylistic and expressive properties of the example movements. Unfortunately, sequence continuation models offer little room for interactive control unless they are conditioned during training on

specific control parameters. Generative adversarial networks have gained tremendous popularity as generative machine learning models. State of the art versions of GANs such as *StyleGANs* excel at producing output that is both novel and realistic. Furthermore, GANs can cope with more or less any type of data and are therefore attractive for a wide range of artistic applications. On the other hand, at least the canonic versions of GANs which are included as tools are challenging to train and make it difficult to control specific aspects of the generated data instances. Autoencoders have been superceded in popularity by GANs because they produce less realistic results. Nevertheless, autoencoders remain attractive for artistic purposes. They offer a wide range of possibilities for generating new data instances whose similarity or novelty compared to original training data can be finely tuned. Autoencoders also offer interesting forms of interaction within latent space of data encodings or within data space itself.

The tools presented in this article are also fairly unique in that they are provided as software libraries and example source code rather than stand-alone applications. Accordingly, these tools are highly flexible and can be thoroughly modified and extended for new artistic realisations. This flexibility is meant to cater to creative practices that embrace idiosyncratic approaches which includes those in Contemporary Dance and Generative Art. This also means, that the tools will mainly appeal to artists for whom the development of generative systems forms a core element of their creative practice. As a consequence, at least some of the tools have a relatively high entry barrier and require

programming skills that might be out of reach for artists who are not familiar with creative coding. For those creative practitioners that lack these skills, the tools might only be of use if they manage to recruit creative coders as collaborators. Fortunately, the involvement of technical experts in creative productions is very common in the field of Dance and Technology. Such forms of collaboration have been thoroughly explored and documented in the creative case studies presented in this article [14, 39, 10].

7. Outlook

The tools presented in this article are very diverse not only with regards to the generative methods they represent but also their immediate usefulness for artistic workflows. The most useful tools have undergone an iterative process in which the development of the tool and the creation of new works mutually influenced each other. This is the case for the simulations of mass-spring systems, articulated rigid bodies, and flocking behaviours and for the autoencoders that operate on pose sequences. The other tools have yet to benefit from such an iterative process. An upcoming dance production provides the opportunity to evaluate and improve the tools for sequence continuation. It is hoped that future productions will also lead to further developments of the GAN-based tools.

At the moment, each of the tools has been used in isolation. It would be interesting to experiment with generative approaches that combine multiple tools. In particular, the combination of simulation-based and data-driven methods represents a very promising

and largely unexplored domain of activity. One approach that employs such a combination is reinforcement learning. The author has previously conducted research with this approach [2] and plans to translate some of the results of this research into additional tools for Contemporary Dance and Generative Art.

While the artistic case studies that made use of the tools involved several collaborators, it has mostly been the author himself who directly worked with the tools. The few exceptions that prove the rule include a media artist who worked with the mass-spring simulation to create most of the visual content for a precursor version of the piece *Strings P* and a computer musician who combined his code for sound synthesis with the autoencoder employed in the piece *Artificial Intimacy*. Motivating other artists to experiment with these tools and contribute to their development is a high priority for future activities. First steps in this direction are currently undertaken in the form of ongoing and upcoming teaching activities about AI and Art and a recently started European research project that deals with the integration of machine learning and extended reality into dance and theatre productions¹³.

Finally, a further research and development direction aims at lowering the tools' barriers for artists with limited programming skills. This direction will likely involve the tools operating as servers running generative systems whose state can be configured and modified remotely by sending and receiving messages. While this approach

¹³ HORIZON-CL2-2021-HERITAGE-01-04:
<https://cordis.europa.eu/project/id/101061303>

doesn't allow to fundamentally change or extend the functionality of a tool, it nevertheless permits an artist to experiment with the tool and integrate it into his or her digital work pipelines. Since these messages can be generated algorithmically with any tool the artist is already familiar with, such a server-based approach can reduce the difficulties in building a customised generative system. This approach has been employed by the author for the *Interactive Swarm Orchestra* system [7] from which the Flocking Behaviour tool is derived.

8. Acknowledgments

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Generative Design of Lattice Structures for 3D Printed Sculptures

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Abstract

First, the Greeks and later the Romans reached a summit of artistic excellence by creating large bronze statues. These sculptures were hollow because the lost-wax technique involved the creation of a non-bronze internal space which was sometimes removed to leave a hollow

bronze shell. After making a positive model nearly the size of the desired sculpture, artists coated it in wax and refined the details directly on the thin wax surface. The entire model was then covered in clay by using rods passing through the internal part of the statue. The wax was then melted away, and bronze was poured into the negative space left by the melted wax. Nowadays, Additive Manufacturing technologies, especially Selective Laser Melting (SLM), Direct Metal Laser Sintering (DMLS), metal Binder Jetting, and lately Fusion Deposition Modelling (FDM) upgraded to Atomic Diffusion Additive Manufacturing (ADAM), allow the printing in metal of sculptural or mechanical models without

the necessity of a core for the support of the model.

Instead of a hollow space, the model's internal part can be filled with lattice structures for structural and aesthetic reasons.

Using generative design and changing various process parameters, lattice structures can be created with specific electrical, mechanical, thermal, and acoustic properties. For this reason, such structures have been researched mainly for technical, rather than artistic, applications.

In addition to the lattice structures that software can create, Generative Design can be used to realize supports for mechanically sound and aesthetically compelling parts.

Only a few artists specifically explored the aesthetic applications of lattice structures and generative design (for example, Neri Oxman from MIT and a few others).

This paper explores the application of the latest software and specific processes to prepare a variety of sculptures exploring both the aesthetic and mechanical possibilities that these new techniques and processes enable.

1. Introduction

The two authors have collaborated for many years in the study and research of AM technologies and applications for engineering and artistic applications.

Professor Picozzi explains how generative design can be used in connection to design and AM processes. To produce various sculptures, Professor Prete compares different software packages to analyze modelling results for

the same initial parameters and different aesthetic aspects of both Generative Design and Lattice structures. An initial step-by-step guide helps the understanding of the software and procedures.

2. Generative Design

A solid object is loaded by applying forces somewhere on its surface. Upon being loaded, the solid responds by undergoing deformations throughout its volume, which are in general partly elastic and partly plastic. The former disappear upon removal of the load, while the latter are permanent. The deformations vary with position within the solid with a pattern that depends in a very complicated way on the nature and location of the loads and, critically, on the detailed geometry of the object. As a consequence of such deformations, the loads applied at the surface lead to forces distributed throughout the volume, whose spatial pattern mirrors that of the deformations. If the forces distribute themselves in such a way that their intensity nowhere exceeds the material's threshold for rupture, the object will sustain the loads without suffering any damage. On the other hand, if that threshold is exceeded at some location, the object will rupture at that location, with the initial damage possibly evolving towards catastrophic failure of the entire structure. An exact calculation of the volume force distribution is only possible for very simple geometries; in nearly all practical applications, machine computation is necessary. Lattice structures offer obvious advantages with respect to continuous solid objects in terms of weight saving, and they may possibly exhibit a particular aesthetic appeal as well. The goal is to design the

lattice geometry in such a way that the resulting structure will meet the same strength requirements as its fully solid counterpart while being considerably lighter. In general, identifying an "optimal" geometry can be difficult even for an expert designer because even minuscule variations in the lattice geometry may lead to substantial shifts in load-bearing properties. Generative design tackles this challenging optimization problem by "testing" multiple geometries until one is found that is "best" according to criteria established by the designer. The testing consists in generating automatically many different variations upon the initial geometry and in computing, for each of them, the corresponding volumetric force distribution. An appropriate algorithm will score the load-bearing performance of each design so that an optimal solution will emerge corresponding to the highest score. Since the process is entirely computerized, the number of geometries to be tested is limited only by the computing time that the designer is willing to allow. Thousands, possibly millions, of configurations can thus be tested automatically, and the final solution to which the algorithm finally converges can inspire sufficient confidence that said solution is close to the absolute optimum within the specified constraints. In generative design, the designer's input is confined to the specification of the problem's constraints dictated by the nature of the application being considered.

The connection between Generative Design and Additive Manufacturing is that the lattice geometries emerging from the optimization process are often too complex to be built by conventional (subtractive or formative) manufacturing

techniques, while the particular capabilities of 3D printing processes may enable the realization of even the most intricate geometries. Moreover, it is possible that the design chosen by the algorithm, while exhibiting superior mechanical properties, may be deemed aesthetically unappealing. In that case, human judgment may override the algorithm's choice and select instead a suboptimal geometry that still meets minimum strength criteria while also being easy on the eyes in a way that an algorithm cannot easily capture.

3. Lattice Structures

Our investigation presents a practical guide in using lattice structure on artistic models by using generative design and software such as nTopology, Autodesk NetFabb, Autodesk Fusion 360 and providing the right dimensioning for the shell and the internal lattice structure to a digital sculpture. Best settings/performances based on shape/scale/dimensions / AM technology used for fabrication will be presented based on our tests.

We can consider a lattice structure a model or a three-dimensional pattern that is repeated to fill a volume.

We can find natural examples of lattice structures in our bones, in the honeycomb of beehives, fungi mushrooms, and bubbles (as Voronoi structure). All these examples are nature's way to provides lightweight structures.



Figure 1: Mushroom hymenium tissue presenting natural lattice structure.

Our analysis considers only lattice structures that can fill a volume (a mesh or a CAD model) or be applied to surfaces. Lattices can be periodic, non-periodic, or stochastic and can be modeled through beams, plates, or Triply Periodic Minimal Surfaces (TPMS).

A cube of 100x100x100 mm is used first to explain the process and procedures. The second example of the actual application of Adam's hand sculpture provides a practical example and consideration of best practices.

Autodesk NetFabb can be easily used to create a lattice structure and provides a good understanding of the steps used to create a simple internal lattice structure.

After creating or importing a basic cube 100 mm x 100 mm x 100 mm (mesh), we can easily drag the model under the "Lattice Assistant" command to select a series of pre-set lattice structures.



Figure 2: Creation of mesh cube on Netfabb.



Figure 3: Selection of Lattice Structure on Netfabb.

A window gives the option to select the lattice structure, the thickness of the wall, and the cell size.

The thickness of the lattice structure is proportioned to the size of the cell. A minimum thickness needs to be established based on the technology used for the fabrication and scale of the model.

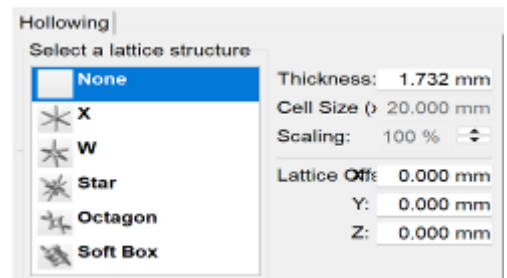


Figure 4: Selection of Lattice Structure type on Netfabb.

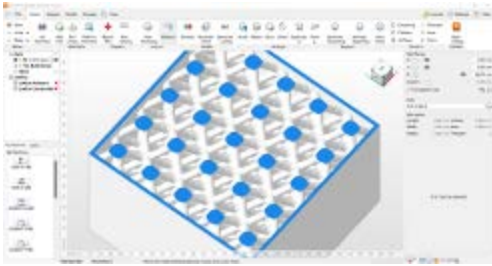


Figure 5: Creation of Lattice Structure type on Netfabb.

With a 20 mm cell and 1.732 mm thickness, we obtain a robust structure with 1/2 of the weight.

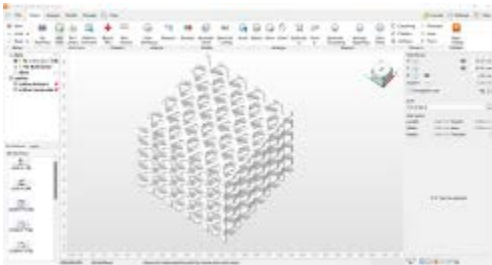


Figure 6: Internal visualization of Lattice Structure created on Netfabb.

After removing the shell, we can see the internal structure with a volume of 165.8 cm³ in contrast to the previous 279.3 cm³.

With a simple beam X structure, we can maintain part of the mechanical qualities important for artistic and cultural applications with half of the weight. The weight reduction is essential as load reduction for calculating the structure itself and as a saving in material and costs during fabrication. Most AM technologies used for 3D fabrication (SLA, FDM, Binding Jetting, etc.) provide good printing without support with overhangs less than or equal to 40° / 45°.

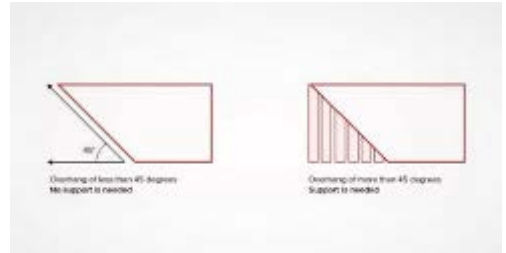


Figure 6: Explanation of overhang less than 45° that is typically safely printable (Source: Mohit via GrabCAD)

If the distance between parts is small enough (horizontally 5 mm) or if the overhang is gradually reached (increasingly proportionate overhang), the angle can be reduced, and additional internal support can be avoided if the orientation is calculated based on the direction of printing.

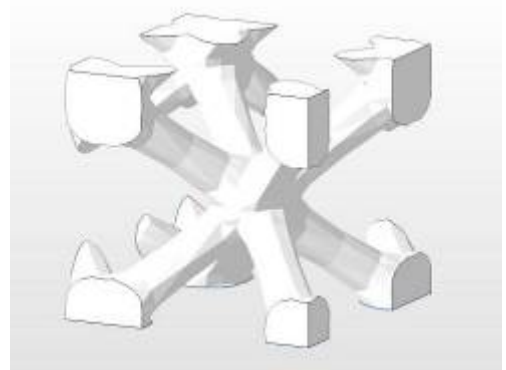


Figure 7: Visualization of the single 20x20x20 mm X unit that presents a max distance of 17.32 mm, 3.6 mm minimum thickness, and angle of 35.26 for each leg.

We also made some considerations based on the AM technologies used for fabrication.

FDM (Fusion Deposition Modeling) in ABS, ASA, PLA, or other thermoplastic can be easily used to print lattice

structures. Most of the time, even desktop printers use proprietary slicer software that can provide a simple internal system regulated by the selected density.

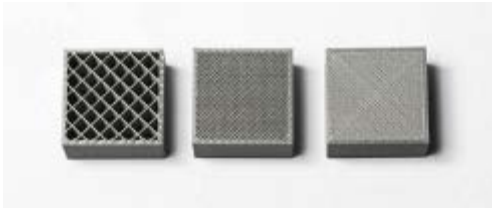


Figure 8: Examples of internal structure 20% density, 50% density and 100% density with FDM printing.

There is no need for additional openings when FDM is used. On the other hand, if technologies such as SLA or Binding Jetting are used, openings for removing the unbonded or uncured materials must be provided in areas that can be easily repaired or filled during the postprocessing of the artwork.

In these last cases, stochastic and beam-based lattices are probably easier to clean than TPMS (where unbonded powder or uncured resin can remain inside).

In addition to the simple use of lattice structures for structural/mechanical reasons with improved lightweight characteristics, we also looked at the relationship between aesthetic and mechanical qualities.

Software such as Autodesk Netfabb or Fusion 360, can easily create a lattice structure based on specific characteristics, but always with a predetermined standard dimension and orientation. Other software, such as nTopology can generate a gradient of lattice structure resulting in an

anisotropic design where the conformal gradient lattice structures are optimized. This kind of lattice structure mimics the natural organization we find in animal bones. Parts under more stress or thinner are filled with dense structure and parts under less stress or thicker with less structure.

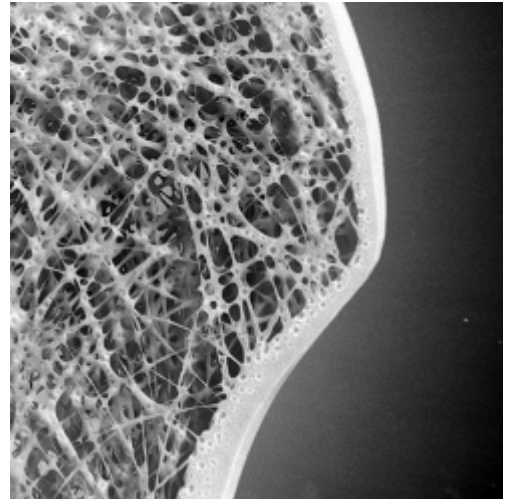


Figure 9: Examples of internal bone structure.

nTopology software provides a easy solution to create conformal lattices showing interesting aesthetic characteristics.

After importing two surfaces that define the top and bottom of our basic cube,

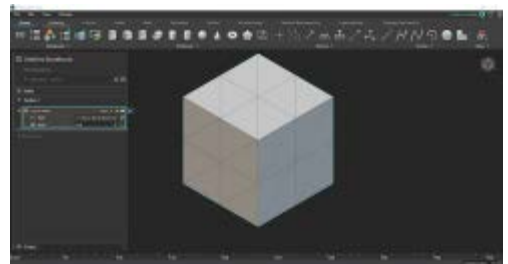


Figure 10: Creation of 100x100x100 mm cube on nTopology.

I used a an eas y tool called "Simple Conformal Lattice between faces" to create my first lattice in nTopology.

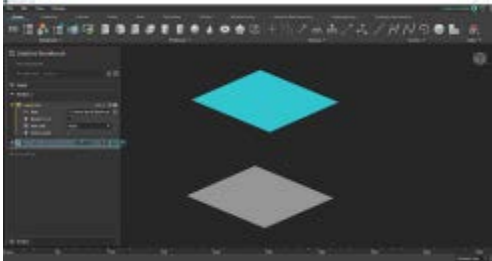


Figure 11: Creation of two faces based on 100x100x100 mm cube on nTopology.

nTopology provides several units that can be used for the structure and also allow the personalization of the unit's design.

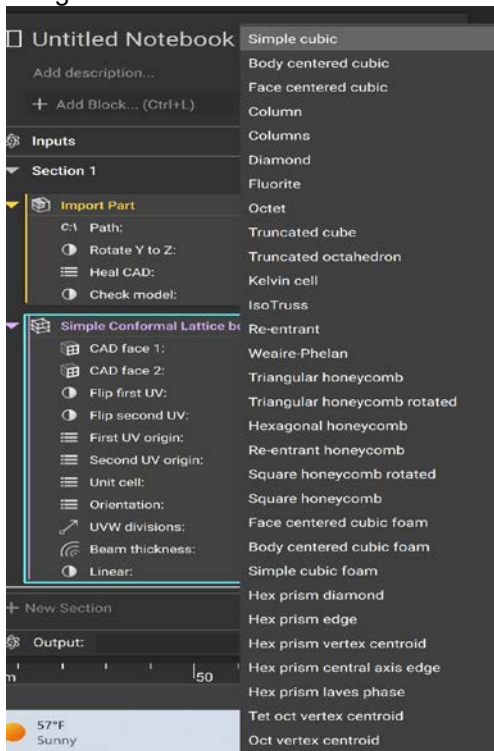


Figure 12: Selection of the unit cell type on nTopology.

A simple cubic design presents similar design of other software.

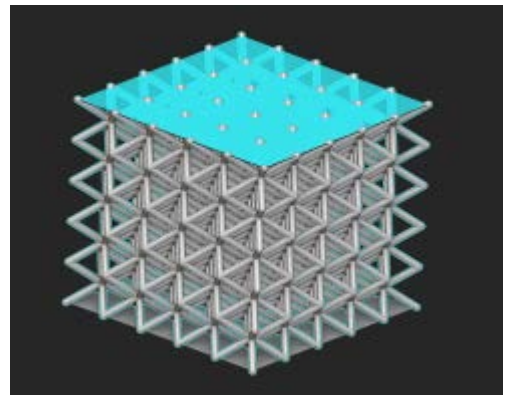
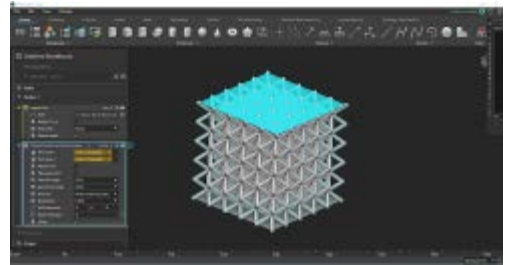


Figure 13/14: Lattice structure created by using "Simple Conformal Lattice between faces" on nTopology.

By changing parameters on U VW orientation or UVW division we can iterate trough different variations for aesthetic or structural reasons.

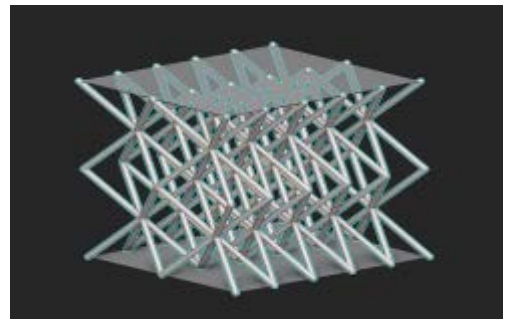


Figure 15: Variatons of lattice structure based on UVW modifications.

In the case of more complex shapes created using other CAD software and imported in nTopology, these parameters can adapt the lattice to the surfaces.

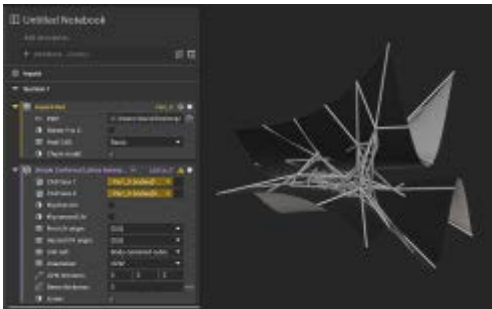
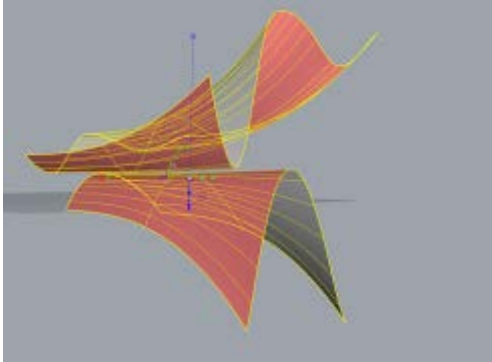


Figure 16/17: Adaptation of lattice structure on more complex surfaces.

Multiple variations can be created by changing basic parameters to achieve different results.

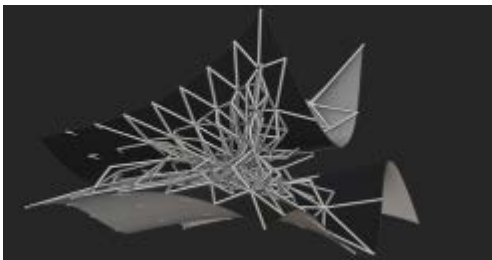


Figure 18: Adaptation of lattice structure on more complex surfaces.

These few examples are far from a detailed description of the tools and capacities of the software and want to be only an inspiration and a starting point for new creative processes.

For a more practical example, Professor Prete worked on a hand sculpture inspired by Adam's Hand to test possible aesthetic values of the lattice structure.



Starting from the mesh and after hollowing the model, a spiral selection of the surface was determined to visualize both internal and external spaces.

The design was just a way to maintain enough understanding of the original mesh and balance the visualization of the internal structure.



A minimum thickness of 2 mm was defined for the lattice structure that covered the internal mesh and mixed it with the original spiral design.



The lattice structure was so created only on the internal mesh obtained from the hollowing operation to reach 3 mm thickness for the shell.



The connection points with the external mesh were left even if outside the surface, creating an interesting connection between the internal "negative space" defined by the lattice and the "positive space" of the spiraled hand. The model was printed in plaster by using binding jetting and infiltrated with epoxy resin.



Key words:

Generative design, additive manufacturing, 3D Printing, computational design, lattice structure.

4. Conclusions:

Software able to create lattice structures, such as nTopology, NetFabb, and Fusion360 are changing how artists and designers adapt supporting structures by analyzing and selecting variations on the same project for aesthetic and mechanical reasons.

Artistic research and creative choices in lattice structures are just beginning and will soon unlock the full potential of generative design, topology optimization, and lattice structures for Additive Manufacturing.

Periodic Structures on Phyllotactic Patterns

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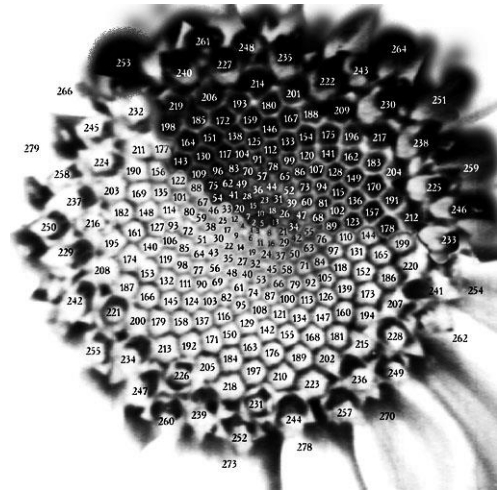


Fig. 1. The projection of two complementary Beatty sequences on the set of florets of a chamomile confluence.

Abstract

The aim of this note is to show the possibility of reflecting some periodic and quasiperiodic sequences on the phyllotactic pattern.

Our approach proposes the distribution of the spectrum of a real number on a polar integer lattice. Plotting on the basis of this principle is considered as a tool for visualizing and studying various phenomena associated with periodicity, be it the movement of celestial objects or the rules of musical harmony. The representation of the spectrum of a number in the polar coordinate system is carried out, in addition, in an analytical (algebraic) form, a histogram and the so-called Bresenham line.

1. Introduction

Everywhere we observe the periodic phenomena, for example, change of day to night, seasons of year, etc. Usually for the image of these time phenomena we use rectangular or circular tables (calendars, dial of hours).

In the general words, rectangular tables are habitual for perception, they transfer originality of varying years, but graphically cycle form, i.e. a circle symbolizing repetition, is lost.

The circular tables are closed, and all periods appear similar to one another.

The spiral form, in a sense, is intermediate. It unites advantages and levels lacks of both forms mentioned above. However, the spiral table is not habitual and is not so easy for perception.

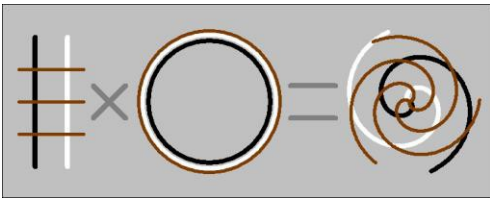


Fig. 2. The spiral shape can be thought of as a hybrid of a rectangular grid and a circle.

Modular arithmetic is the reliable tool for work with calendars.

This paper has its origins in the conception of phyllotaxis. Phyllotaxis studies the symmetrical (asymmetrical) constructions determined by organs and parts of plants. "New light has been cast on the subject with the realization that phenomena similar to phyllotaxis occur in realms outside of botany" [1].

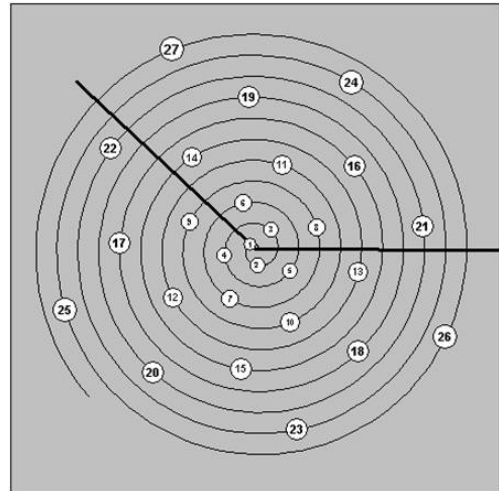


Fig. 3. The plots in the polar coordinate system are united by location of the points of the spiral with a given angle of divergence.

We will conventionally designate this coordinate system as *phyllotactic*. Such concepts as the spectrum of a real number, Beatty sequences inclusively, continued fractions, Euclid's algorithm, two-dimensional crystalline projection, Bresenham's line, the spirographs theory come into view.

The periodic sequences in the polar coordinate system are often depicted in one dimension. Only the angular component with a unit radius is taken into account (the clock face, the spirograph theory, musical rhythms based on the Euclidean algorithm, the circle of fifths). In the phyllotactic system, both parameters – an angle from a reference direction and a distance from a reference point – are variable. We believe that the Archimedean and Fermat's spirals are convenient for this purpose.

2. The spectrum of a real number

The spectrum of a real number α is defined to be an infinite multiset of integers.

$\text{Spec}(\alpha) = \{[\alpha], [2\alpha], [3\alpha], \dots\}$; $[x]$ = the greatest integer less than or equal to x (floor); [2]. If α is an irrational number, then $\text{Spec}(\alpha)$ is called a Beatty sequence. If α and β are positive irrational numbers such that $1/\alpha + 1/\beta = 1$, then the Beatty sequences $[\alpha], [2\alpha], \dots$ and $[\beta], [2\beta], \dots$ together contain all the positive integers without repetition.

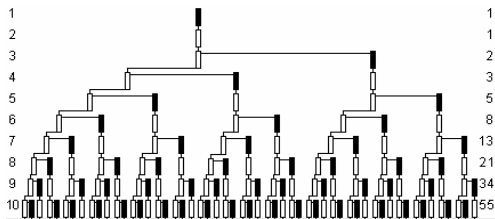


Fig. 4. Genealogical tree of Fibonacci rabbits. Fibonacci chain.

There is a remarkable sequence of 0s and 1s, which is intimately related to the Fibonacci numbers and to Phi. There are different ways to generate this Fibonacci chain or Rabbit sequence.

The Substitution Map

$0 \rightarrow 0\ 1$

$1 \rightarrow 0$

gives

$0 \rightarrow 0\ 1 \rightarrow 0\ 1\ 0 \rightarrow 0\ 1\ 0\ 0\ 1 \rightarrow \dots$,

giving rise to the sequence

$0\ 1\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ 1\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ 1\ 0\ 1\ 0\ 0$
 $1\ 0\ 0\ 1\ 0\ 1\ \dots$

Here, the zeros occur at positions

1, 3, 4, 6, 8, 9, 11, 12, ... ,

and the ones occur at positions

2, 5, 7, 10, 13, 15, 18, ...

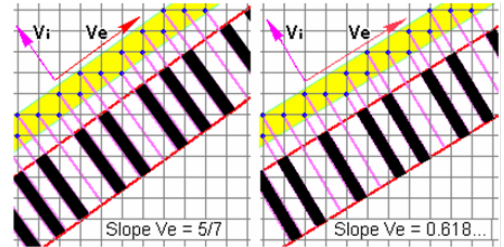


Fig. 5. Projection of a two-dimensional lattice onto a one-dimensional space with a rational slope (5/7) (left) and an irrational slope $(\sqrt{5}-1)/2$ (right) to obtain a one-dimensional approximant and quasicrystals, respectively. If the slope of the vector V_e , equal to the tangent of its angle with the horizontal, is rational number, then the sequence turns out to be periodic. If the slope is irrational, then, respectively, the sequence is non-periodic, or quasi-periodic.

The concept of the spectrum of a real number which is closely related to Bresenham's "midpoint line algorithm" and Euclid's algorithm finds its way into calendrical calculations. *Bresenham's line algorithm* is a line drawing algorithm that determines the points of an n -dimensional raster that should be selected in order to form a close approximation to a straight line between two points. Dershowitz et al. derive some general formulas that are useful in calendrical conversions for the Julian, Islamic, Coptic, Hebrew, arithmetic Persian, and old Hindu lunisolar calendars [3]. We illustrated some calendar systems in phyllotactic representation with computer animations. Among them there is the Runic calendar, the 532-year "Victorian" or "Dionysian"

cycle for the date of Orthodox Easter, Julian Easter perpetual calendar which allows you to define the day of the week and the day of Orthodox Easter.

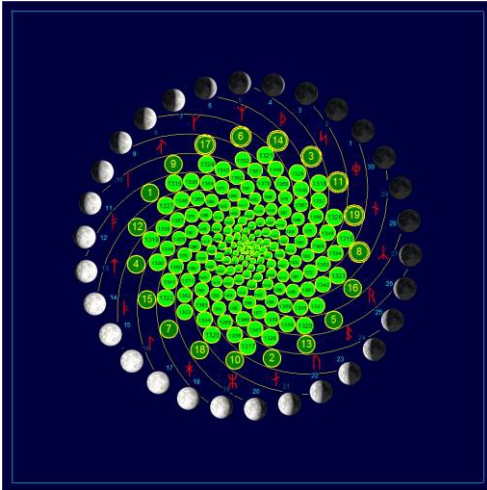


Fig. 6. Phyllotactic pattern of Metonic Cycle. Scandinavian lunar calendar.

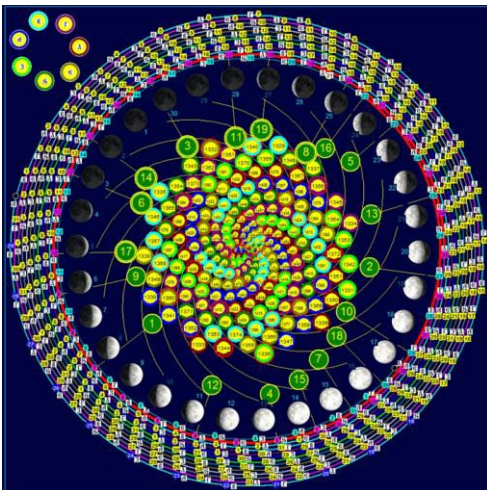


Fig. 7 Julian Easter perpetual calendar.

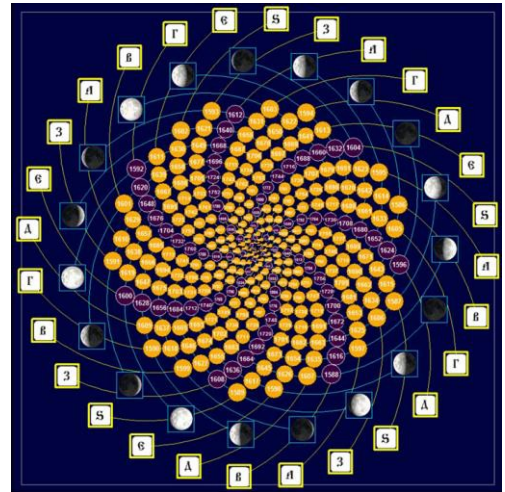


Fig. 8. The 532-year "Victorian" or "Dionysian" cycle.

The spectra of the numbers 12/7 and 12/5 provided a pattern of piano keyboard, and their projection onto the phyllotactic sample with divergence angle $360^\circ \cdot 5/12 = 150^\circ$ gave a two-dimensional layout of a one-dimensional circle of fifths.

The figures below show four ways to graphically represent the spectrum of a real number. In each illustration, the upper left quadrant shows phyllotactic pattern; upper right quadrant shows keyboard one (similar to a piano keyboard); lower left quadrant shows the analytic representation; lower right quadrant matches Bresenham's line algorithm. The sequence of the ratio of neighboring Fibonacci numbers, musical fifth (7/12), the Leap years cycle and the Metonic cycle are chosen for example.

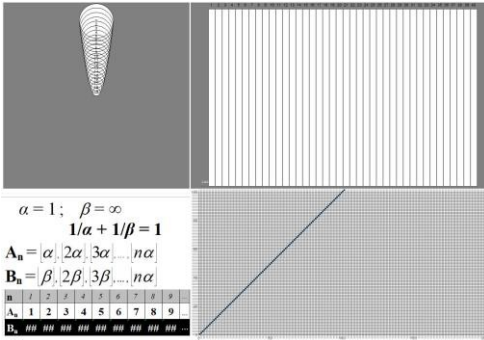


Fig. 9. $1/\alpha = 1/1$

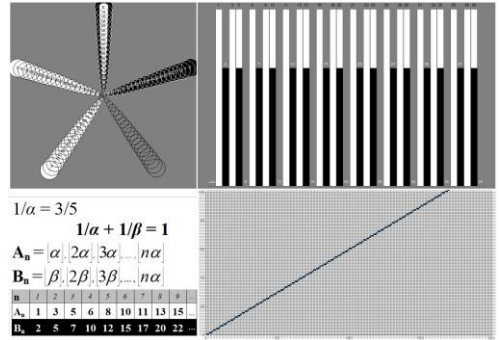


Fig. 12. $1/\alpha = 3/5$

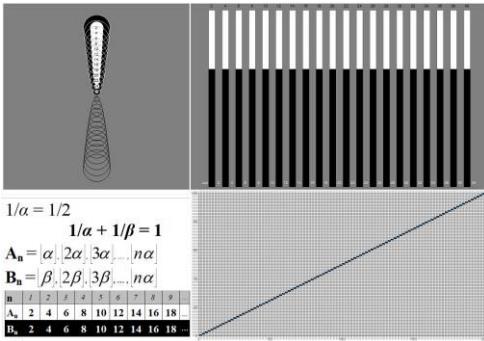


Fig. 10. $1/\alpha = 1/2$

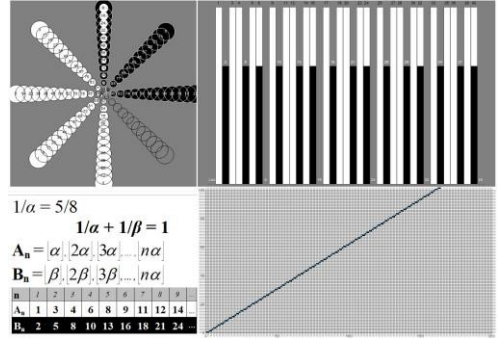


Fig. 13. $1/\alpha = 5/8$

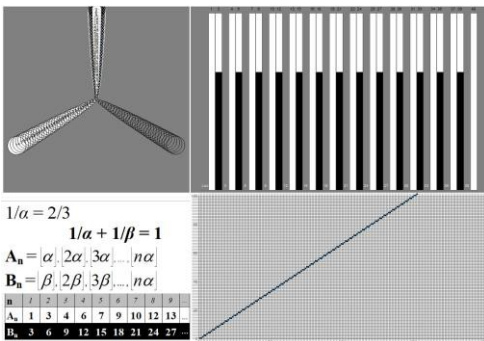


Fig. 11. $1/\alpha = 2/3$

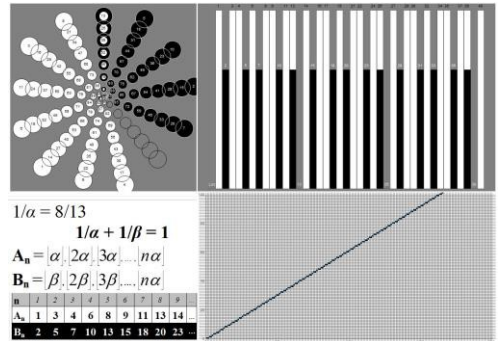


Fig. 14. $1/\alpha = 8/13$

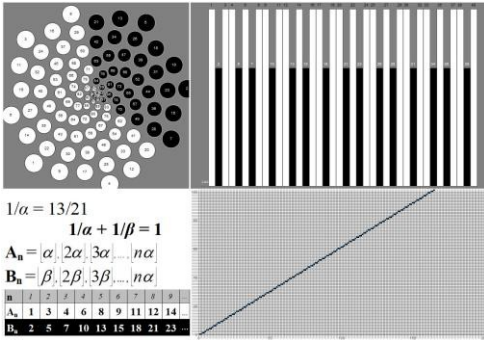


Fig. 15. $1/\alpha = 13/21$

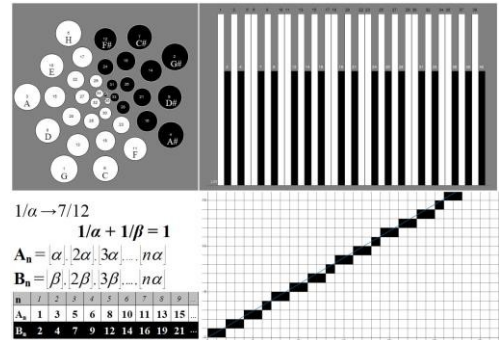


Fig. 18. Circle of Fifths

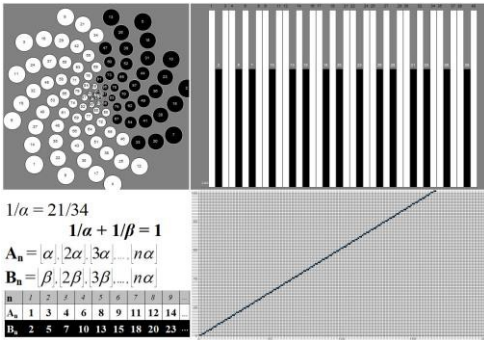


Fig. 16. $1/\alpha = 21/34$

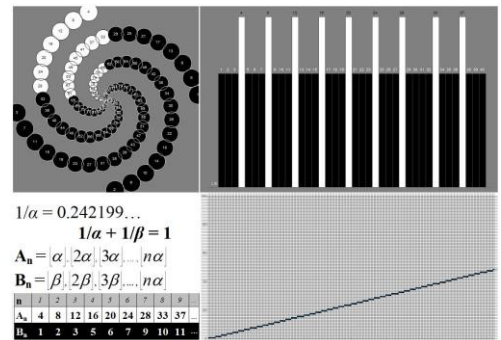


Fig. 19. Leap years

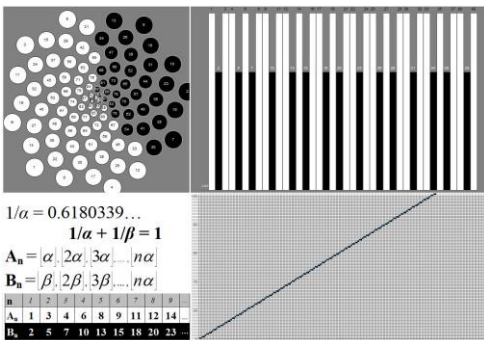


Fig. 17. $1/\alpha = 0.6180339\dots$

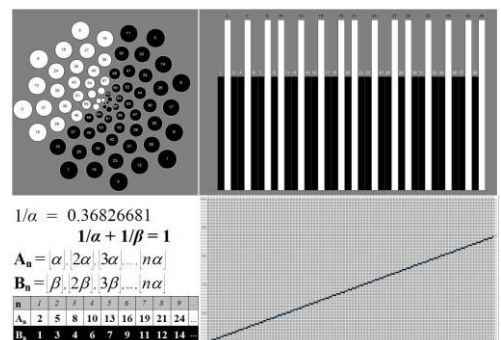


Fig. 20. Metonic Cycle

3. Simultaneous Cycles

“Some calendars employ two cycles running simultaneously.” [3].



Fig. 21. Chinese calendar 60-year cycle.

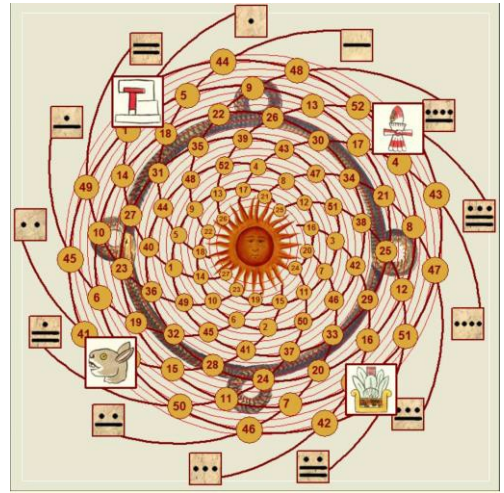


Fig. 23. The Xihuitl, The Cyclic 52-Year Calendar.

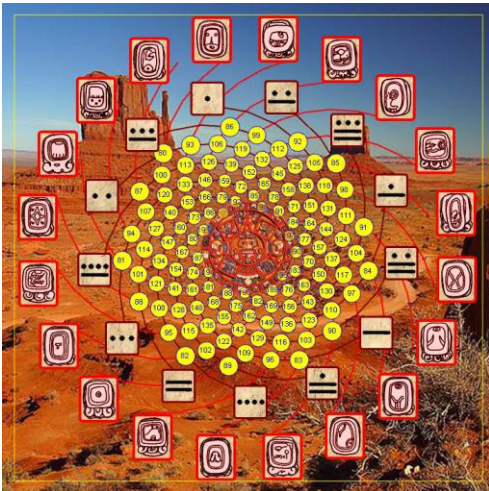


Fig. 22. The Tzolkin calendar.

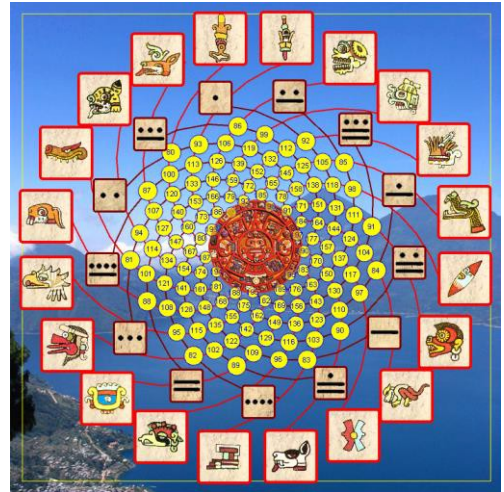


Fig. 24. Tonalpohualli, meaning “count of days” in Nahuatl, is a Mexica version of the 260-day calendar in use in pre-Columbian Mesoamerica.



Fig. 25. "Daariisky Krugolet Chisloboga".
The phyllotactic pattern $9 \times 16 = 144$.

4. Conclusion

On the one hand our article shows that phyllotactic patterns can be used to illustrate known structures in a new way, by transposing them into another coordinate system. On the other hand, the projection of integer sequences onto the phyllotaxis lattice is in line with the Cognitive Visualization concept proposed by Alexander Zenkin. "Cognitive Visualization aims to represent an essence of a scientific abstract problem domain, i.e. the most principal connections and relations between elements of that domain, in a graphic form in order to see and discover an essentially new knowledge of a conceptual kind" [4].

5. References

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Symmetry as repetition

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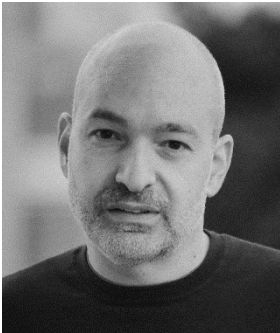
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Abstract

Symmetry is an old ordering principle that has inspired and explained the developments in many different scientific and artistic fields, like physics, biology, or architecture. In a moment when contemporary design experiences an increasing geometric freedom, why does

a traditional subject like symmetry could be of interest for designers? It seems reasonable to question the value of symmetry in contemporary, computationally driven design.

Klaus Mainzer resumes the current tendencies as a move from symmetry to complexity, where the platonic union of truth and beauty is broken and transformed into diversity and heterogeneity. Indeed, the digital avant-garde embraced the power of digital computation with great enthusiasm, which resulted in new emergent generative or evolutionary systems of forms. For example, we can conceive of organic forms as something which is produced by the interaction of numerous forces which are balanced against one another in a near-equilibrium that has the character not of a precisely definable pattern but rather of a slightly fluid one, a rhythm. In that context, symmetry might initially appear irrelevant or even as a counter principle.

Complexity is mid-point between order and disorder. When complexity is symmetric, two core determinants of visual aesthetics come into play. Natural structure suggests the necessity for

differentiation, followed by collective organization marked by a high degree of multiple symmetries. Architectural evidence reveals the principle of broken symmetry as a key feature of buildings that mimic living structure. The present paper offers an attempt towards such an approach of exploring balance between searching and breaking the codes of harmony, breaking symmetry, then using it again.

As the understanding of aesthetics has been recently shifted from the traditional study of beauty towards the redistribution of the sensible, an idea developed extensively by Jacques Rancière, we can approach symmetry through a similarly different lens: Not as a property of sameness but rather as repetition that operates in terms of difference. The mirrored doubling of symmetrical processes can be seen as process that produces rhythm, modulation and ultimately difference.

The art of petrified silence

Structure speaks through the silence of perceptual phenomena. [1] Deleuze and Guattari describe three disciplines of thinking: science, art and philosophy. [2] Science fixes the world into observable 'states of affairs'. Philosophy creates concepts; these concepts do not label or represent the world so much as produce a new way of thinking and responding to problems. Art creates affects and percepts. Our senses are the transducers from the physical world to the realm of the mind. The percept is the resulting mental re-creation of the sensory information. Images of one sensory realm feed further imagery in another modality. In Okakura's

description the present and the absent, the near and the distant, the sensed and the imagined fuse together. [1] According to Brentano, physical phenomena engage our "outer perception", while mental phenomena involve our "inner perception". The challenge for architecture is to stimulate both inner and outer perception. In memorable experiences of architecture, space, matter and time fuse into one singular dimension, into the basic substance of being, that penetrates our consciousness. [1]

"Art does not exist in itself; it is an outcome of a complex set of relationships between what one is allowed to say, to perceive, and to understand", Jacques Rancière.

Since the late 1990s, Rancière has put forth one of the most novel and powerful accounts of aesthetics. Instead of taking art to be a historical constant and attempting to unveil its fundamental essence, he maintains that there is no "art in general" but only historically constituted "regimes" that establish a given distribution of the sensible and determine the framework of possibility for artistic production and theoretical reflection on art [3]. The French philosopher relates aesthetics to what he calls the "sensible," a noun that evokes perception and the senses (aisthētikos) rather than reason or good judgment. Aesthetics, is understood as a specific construction, distribution and perception of the sensible [4] in the sense that it redefines the very constituency of the sensorium. For Rancière, *"both industrial production and artistic creation are committed to doing something on top of what they do—to creating not only*

objects but a sensorium, a new partition of the perceptible".[4]

Sensory perception is a realm structured by practices of repetition, that structure, rhythmize, and connect objects, events, and actions. The sensory perception of a certain materiality is turned into the starting point and goal of artistic practices. Art apportions a certain space and a certain time, and the objects with which it populates this space, and the rhythms into which it divides this time, determine a specific form of experience that is consistent or breaks with other forms of experience. [5] Rancière's work begins with the premise that our world is composed of lines in constant movement, alignment and realignment, these "dividing lines" that divide and connect aesthetic formations. There can be sought that possibility of "change through repetition" as rooted in the transformability of any distribution of the sensible. [5]

9 points on symmetry, repetition and difference

Symmetry has been a property that the 'traditional' understanding of aesthetics have been dealing with. However, when symmetry is understood through the concepts of repetition and difference Rancière's aesthetics as the redistribution of the sensible might come into play. In other words, when the act of generating symmetry is understood as an act of repetition that is able to generate difference then our understanding of the perception of the produced space is shifted. The example presented at the end of the paper, reveals exactly this emergence of difference through multi-layered form forming acts of symmetrical

repetitions. Below, 9 points on the concepts of symmetry, repetition and difference set the general theoretical framework.

Point 1: Microgenesis of regularity

Most natural laws and occurrences, such as the coming and going of waves, the change of day and night, the changing of seasons, tides, breathing, heartbeat, pendulum movements, etc., are different manifestations of periodicity in time. The repetition of occurrences or states in identical time intervals is called rhythm (Ghyka 1977, p. 6; Alyakrinski and Stepanova, 1985).[6] Practices of repetitive structure, rhythmize, and connect objects. It is the object of repetition that deceives because it repeats but is never redundant. It remains somewhere between uniqueness and duplication, uncertain of either but certain of itself.[7] Repetition is a process that underlies all identities. It is that double identity of the "new" and the "repeated" that gives the letters for a new language to be formed. It is through the unique language of repetition that structure's poetry and lyricism are exposed.



Fig.1

Point 2: Difference within sameness

Derrida argues: *The verb "to differ" [différer] seems to differ from itself. On the one hand, it indicates difference as distinction, inequality, or discernibility; on the other, it expresses the interposition of delay, the interval of a spacing and*

temporalizing that puts off until "later" what is presently denied, the possible that is presently impossible. [8]

Pure difference cannot be represented affirmatively by any concept that reduces it to being merely an absence of sameness. Representation thus considers difference to be a contradiction of sameness. Just as repetition implies a relation between a "repeater" and a "repeated," difference implies a relation between a "differenciator" and a "differenciated.[2] Repetition as a creative tool produces not merely copies, but rather multiple originals with noticeable differences and similarities. It is that repetitious act and particularly the sameness of each unit that draw attention to their difference. Furthermore, ruptures affected by repetition offer the possibility of a redistribution and reapportioning, a transformative reconfiguration, proposing new connections, activating previously overlooked capacities. [5]

Difference is not merely dependent on its relationship between two things, but rather is itself emergent and processual. The cycle of repetition is an emergent act, allowing difference to relay both distinction and delay. The latter promises another difference, another original, to add to the collection. It is through repetition that difference is invited and maintained. That is how repetition allows differentiation to emerge [7], serving as an anchor from which difference emerges. This echoes Deleuze's concept of repetition: "*Difference is this state in which determination takes the form of unilateral distinction. We must therefore say that difference is made, or makes itself.*" [9] In the end difference is entirely

represented by the unique object of creation.

Point 3: Simplistic vs complex repetition

Simplistic repetition is one such minimalistic geometrical setting in which we find no algorithmic complexity, hence no visual and intellectual interest. Usually, we recognize **such** monotonously repeating forms as unnatural. [10] Indeed, in nature we almost never find simplistic repetition on the macroscopic level. On the contrary, living structures show so much variation in the repetition that monotony is entirely avoided. Inanimate physical structures also almost always have some variations that prevent the monotonous effect to emerge.

A "bare" (simple) repetition is a mechanical, stereotyped repetition of the same element, whereas a "clothed" (complex) repetition is a repetition that conceals its own variability, and it may thus conceal difference within itself. [9] Complex repetition may have various elements that multiply or reflect each other. Pure difference may be reflected by complex repetition because both difference and repetition may be independent of any relation of sameness, similarity, resemblance, or equivalence between events or meanings. Repetition might be static when considered through sameness, but it becomes dynamic as long as we see it through difference. The play of repetition between sameness and difference is also the play of repetition between simple and complex repetition, between covered and uncovered repetition, between masked and unmasked repetition, between horizontal

and vertical repetition, and between static and dynamic repetition. Repetition therefore operates between all those dualities and gains its value through their juxtaposition. As shown in figure 2, a sphere is transformed into an intricate structure, using a play between simple and complex repetitions as a process. That double play can also be detected in the final result.



Fig.2: A play between simple and complex repetition, digital 3d study model, experiments stage II/ Final thesis. Fall 2019, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Students: D.Alexiou, Instructor: Dimitris Gourdoukis.

Point 4: Organized complexity

The Latin term "structura naturalis" refers to the immense range of concrete, physical, and natural structures that surrounds us in daily life. However, when one thinks about these structures, or form abstractions, or uses language to describe them, one is generating a "structura mentis"- a mental structure. These structures can equally go on to produce structura naturalis, in the form of the structures of the world. [11] While structura mentis is a potentially infinite domain of creative expression, structura

naturalis is however, a much more concrete structure, with more specific and predictable human effects and consequences. Planners and designers must be clear about the relation of the two, and the coherence or the discord between them. The first step to discovering the geometric qualities we are looking for is to examine natural environments. This brings us to the effect of Biophilia.

Human beings prefer ordered complexity and not randomness in their environment, a result of our perceptual system evolving to interpret natural forms. [10] Some insight into the effect comes from the notion of Biophilia, which asserts that our evolution formed our neurological system within environments defined by a very high measure of a specific type of coherent complexity. That is, our neurological system was created (evolved) to respond directly and exquisitely to complex, fractal, hierarchical geometric environments. Edward O. Wilson used the term to describe an innate connection between all living beings.

Many ways of achieving order in complexity exist, involving continuity, different types of symmetries, scaling, correlations, harmony, etc. Most environments exhibit compound symmetries, including reflectional, rotational, translational, scaling, and broken symmetries. Humans are adept at perceiving these symmetries and the order that they manifest. Simple in nature means extremely complex but highly coherent.





Fig.3: Delving into details, digital 3d s tudy models/ Final thesis. Fall 2019, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Students: D.Alexiou, Instructor: Dimitris Gourdoukis.

Complex geometrical properties are emergent; they are not obvious in the initial code. [12] Through a generative schema increasing complexity during the design process leads to high resolution architectures, allowing access to a higher degree of complexity giving the chance to delve into details on closer inspection, accessing different resolution at different scales. The challenge however, is to simulate complex phenomena while keep them in the realm of control. Symmetry as a generative process looks like the ideal means of organization to form “controlled” emergent complexity and eliminate chaos and anarchy. In a moment where contemporary architectural discourse balances between doing everything the same and doing everything different, exploring symmetry through digital means might provide a powerful design strategy to negotiate the best of both tendencies. [13]

Point 5: Symmetry as process and product

The contemporary application of theories of symmetry to architecture and design is a surprisingly neglected area of research. To assist in rectifying the problem, a new agenda for research is needed. Design exploration of symmetry can attract a renewed interest based on two main ideas: On the one hand, symmetry-based

design supports the generation of unique and apparent complex solutions out of simple geometric rules, in a bottom-up fashion. On the other hand, despite this intricacy, it assures modularity in the design components, which can bring benefits at the construction level [13]. Also symmetric transformations (isometric or non-isometric) are used as a generative engine to discover new design possibilities.

It is clear from the existing literature that symmetry is a central component of human perception and understanding, and one with its roots in the biological need to apprehend the structure and meaning of the world. Symmetries in the living have their roots in the morphogenetic processes of growth, including folding, rotating, replicating, and so on. One can see the essential relationship between process and product.

The pursuit of symmetry in human structures stretches back to antiquity, and even deep into prehistory. The word symmetry originates with the Greek *sym* (together) + *metron* (measure), and thus refers to a correspondence between different forms with similar measurements or shapes. [11] Some theorists have proposed that “information”—understood as symmetrically related structure—is the fundamental structure of the Universe. That is, the structures of the Universe transform and differentiate from one another but preserve some symmetric relationships in combination with various forms of “symmetry-breaking,” or differentiation into other structures. [14] This broader perspective helps to set the context for the exploration of symmetry

as a phenomenon of both process and product.

Point 6: Types of symmetry

In geometry, the “symmetrical” form in question is said to be invariant under a given transformation, which may include reflection, rotation, translation, scale changes, or other changes. [15] Compound symmetries, which combine other kinds of symmetry into more complex forms, are what is experienced most in natural and human environments. In that context combination of reflectional and translational symmetry is what is known as glide reflection. The three basic plane symmetries, plus their 14 possible combinations, form 17 symmetry groups in two dimensions. Humans crave highly complex forms of compound symmetries with deep coherent inter-linkages, or what one may call “deep symmetry”. Connectivity and integration are central factors in experiencing our environment. We react with alarm at structures that exhibit no scaling coherence but visual coherence at all scales is perceived as “beauty”. [16]



Fig.4: Compound symmetries, digital 3d study model, experiments stage I/ Final thesis. Fall 2019, post graduate program ‘Advanced

Design’, School of Architecture, Aristotle University of Thessaloniki. Students: D.Alexiou, Instructor: Dimitris Gourdoukis.

Another important process of symmetry formation and transformation is symmetry breaking. Broken symmetries are often seen compounded with other symmetries in the irregularities of our world. [11] Symmetry breaking stabilizes the hierarchy against collapse. A careless use of symmetries to generate larger-scale forms leads to informational collapse: when the information contained in the whole is no more than that contained in the repeating unit used to generate it. Then, the information of the whole collapses into that of the single unit. Complexity that is most psychologically satisfying exhibits information on every scale.

In conclusion, the research agenda of symmetry seems to be multidimensional as different parameters concerning the combinations and ultimate choreograph of symmetries comes into play and contribute to the product’s final coherence.

Point 7: Mirror symmetry and perceived objectness

To human observers, there are substantial perceptual differences between kinds of visual regularity. Most comparative studies are dedicated to contrasting the two most prominent cases, namely mirror symmetry and translational symmetry that are regularities that the human visual system uses to process and structure the information that enters through the retina. [17] As far as the idea of perceived objectness is concerned, these studies show for instance that mirror symmetry is

more salient and more noise-resistant than translational symmetry. In fact, they seem to have opposite effects on the perceptual formation of objects. Mirror symmetry seems to integrate pattern halves into perceived wholes, while translational symmetry rather seems to signal the presence of two distinct objects. They also had participants discriminate between symmetric and repetitive patterns in which the pattern halves were either adjacent or separated by a fixed distance. They found that mirror symmetry is more salient than translational symmetry when there is no spatial separation between the pattern halves but the opposite is true when there is. Apparently, manipulation of the distance between pattern halves within the projection plane has different, if not opposite, effects. [17]



Fig.5: Mirror symmetry with no spatial separation between pattern halves, digital 3d study model, experiments stage II/ Final thesis. Fall 2019, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Students: D.Alexiou, Instructor: Dimitris Gourdoukis.

Point 8: The pattern behind pattern

Symmetry can help us towards a journey of reestablishing the inherent poetics in

form. The lines of a design are extended out invisibly. "Form, I believe," says Cecil Balmond, "is something deeper than what we see. It's a more innate, hidden imperative. Form has something to do with the configuration in space of connectivity. It is the rhythm of those connectivities that provoke deeper resonances, the feeling of deeper archetypes. Form is very complex because it has different layers; it's never a one's statement thing." Beauty is mysterious, and hard to pin down, moves on hidden planes, away from the physical fact and the literal towards an inward magnification. It includes small parts of awkwardness along with the smoothness of symmetry. [18]

Using symmetry as a generative process of aligning different patterns of repetition in different ways through an algorithmic logic, products of higher level of complexity that differ from the initial structure and between themselves can emerge. By observing the outcomes of that process, the difference between how it started and how it ended is obvious, while their style of becoming is hidden, sometimes more and sometimes less, but always implying.



Fig.6: Digital 3d study model, experiments stage II/ Final thesis. Fall 2019, post graduate program 'Advanced Design', School of

Architecture, Aristotle University of Thessaloniki. Students: D.Alexiou, Instructor: Dimitris Gourdoukis.

Point 9: The tool / Algorithmic logic

It is remarkable that the concept of structural order can be reached from different viewpoints: we can use science to discover how structures are put together coherently; we can use art and architecture to do the same thing. [12] Nature's code influenced design to adopt the idea of digital morphogenesis. Biology, design and architecture are focused among other things, on morphology. That morphological exploration is based on a metamorphosis or a transformation. Morphogenesis, properly applied, would have to enter the realm of algorithmic design as an abstraction of nature's generative processes and strategies, instead of plain verbatim copies of natural form. The aim of design may not be alive constructs, but it could also be structures that possess properties of living systems, rhythms and connection.

John Frazer observed that many of the breakthroughs necessary for the development of an evolutionary model of design occurred outside the field of architecture. In addition to the dramatic achievements of genetics and evolutionary biology, innovations in mathematics, computational modeling and physics provided the impetus for many of the early experimentations with evolutionary design techniques. [19] The onset of computation has, however, offered us the chance not only to reconnect architecture with geometry, but also to realize the opportunities of other

branches of mathematics and logic, such as algorithms.

When there is a need for a new way of thinking, we need to go through a "creative generative logical process". By externalizing the architecture of thought in the form of an algorithm through coding, designers are introduced into the realm of digital consciousness. A realm where human imagination's limitations could be extended. Algorithms can orchestrate the geometry from the macro scale down to the perplexing level of detail thus uncovering previously unseen aesthetics, blurring structural and ornamental dimensions leading us to an understanding of structure ornamentally. Algorithms in essence, are providing a way of redistribution of the sensible, firstly within the design process and subsequently through the results that they produce. Therefore, algorithms produce new aesthetics beyond the traditional understanding of the term.

If these tools at the beginning of the computer era seemed to threaten human creativity today by allowing us to operate on codes creatively directly, they become tools that open new fields and enhance our understanding of creativity as an indissoluble synthesis between art and science.

Final coding-an experiment

The following example is part of a final thesis, entitled "At the edges of infinity", at the post graduate program 'Advanced Design', at the School of Architecture of the Aristotle University of Thessaloniki, in the fall of 2019. In the experiments different forms were explored by a

sequential and procedural methodology using a core algorithm. The core of the methodology was to create an algorithmic process and not a final form, as a generative system moves the focus from static models into a computational logic to a coding of the design intent. The form of what is build, evolved through code as it is build. The source of the morphogenetic process can be found at the multiplicity of elements and local relations that create the order of the system. Emergent structure combines what is already there into a new form. The whole changes according to its context thus it becomes unique through the difference produced by its localized repetition.

STAGE I

In practice, it all began with a sphere and in a sense the final collection of objects is a collection of "twisted", altered spheres. The process began with the creation of an algorithm that interferes with the sphere and alters it.



Fig.7: Altered sphere, digital 3d study model, experiments stage I/ Final thesis. Fall 2019, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Students: D.Alexiou, Instructor: Dimitris Gourdoukis.

The algorithm responsible for the transformations is split into pieces, into different "actions". There are three basic such actions: First, it operates evolutionarily and as described in its diagrams, the letter G (G1, G2 etc) corresponds to "Generation increase". That means that there is an increase in the number of generations. The number of generations was defined based on the number of faces of the initial sphere. The letter D on the charts corresponds to additional "Data" information. Immediately after a generation increase, all new data is computed and stored (creating a library internal to the algorithm and its function). The letter A on the charts corresponds to "Adaptations". During an adaptation phase, the number of faces does not increase, so we do not change generation. Geometry and spatial arrangement however, can change during that part of the process.

In this process, the algorithm evolved and developed, and through continuous experimentation the objects / altered spheres produced by it, were also developed. The objects that began to be produced, and that retain the characteristics of the initial sphere, are a very small subset of the possible expressions of the first form of the algorithm.

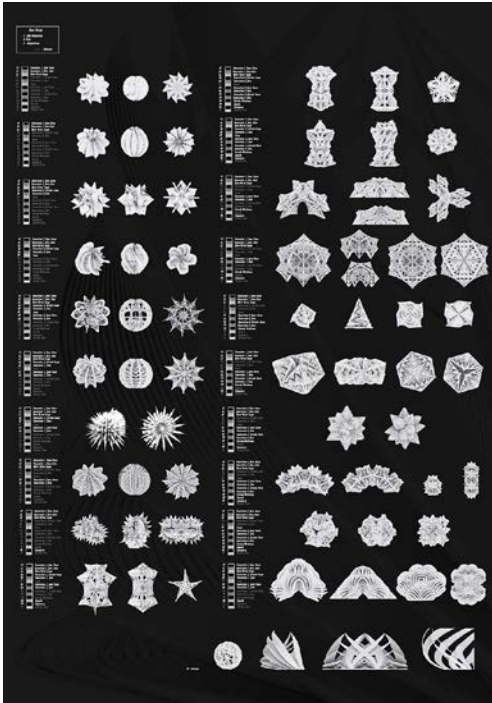


Fig. 8: Experiments stage I, digital 3d study models / Final thesis. Fall 2019, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Students: D.Alexiou, Instructor: Dimitris Gourdoukis.

STAGE II

At this point, the algorithm itself evolved and changed the form of the resulting structures extensively. In the previous procedures, a logic of flocks was added. From selected vertices of the sphere, agents originated based on the normal vectors of these vertices, and began to delineate curved trajectories as a result of the rules of the flock. Different parameters were used that changed the fields in which the flocks were moving. The flows produced were then added to the algorithm so that they could be used as a framework which ultimately guides

the evolution of the structures. The sphere somehow 'spreads' on the flows. At some point the structures continued to be built in a symmetrical way, thus increasing in detail.

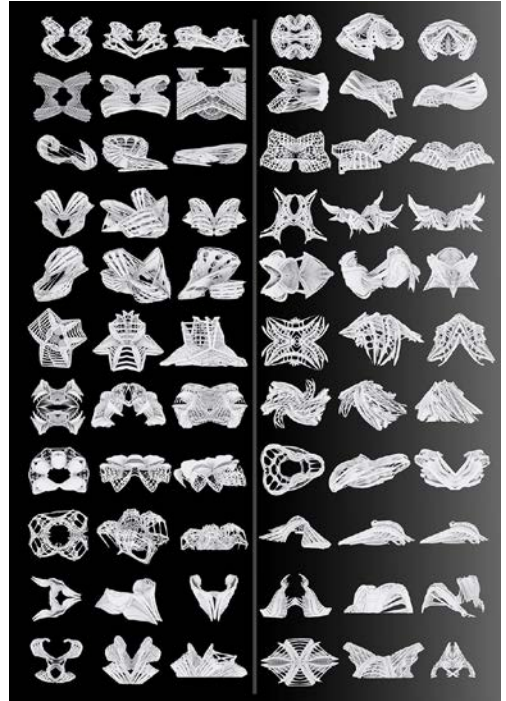


Fig. 9: Experiments stage II, digital 3d study models/ Final thesis. Fall 2019, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Students: D.Alexiou, Instructor: Dimitris Gourdoukis.

The power of algorithmic design is hidden in the details as shown in the images of both digital and analogue models. The character of the final models and the landscape that hosts them results from a combination of the common history they share and created them, from small doses of awkwardness that results from the unpredictability of the results, and the kaleidoscopic qualities that symmetry added. The

difference between how it started and how it ended is obvious in the final collection of objects. All the objects started as a sphere. At the stage I the use of multiple symmetries, patterns of repetition, used one after the other led to the dominance of the kaleidoscopic qualities at the final form, while during the stage II experimentations where the symmetry broke using field effects a different aesthetic were added into the equation. The equation that describes how symmetry through repetition leads to the emergence of difference seems to open up new questions and new possibilities for further experimentations.



Fig.10: Analogue 3D printed models/ Final thesis, fall 2019, post graduate program 'Advanced Design', School of Architecture, Aristotle University of Thessaloniki. Students: D.Alexiou, Instructor: Dimitris Gourdoukis.

“At the edge of chaos, in areas of bounded instability, on the boundary between order and chaos, there is enough stability to have repetitive and predictive elements in the system, but just enough instability to generate novelty

without creating anarchy and dispersal.” (Zimmerman, Lindberg and Plsek, 2001)

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Generative design principles and algorithmic thinking in architectural plan variations: human to machine approach

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Abstract

The design process based on analogue architectural plan variations has been analysed in order to determine generative principles for its automation. It has been presumed that the limitations of the current artificial plan generator models could be mastered and overcome by establishing a closer relationship between the natural design process and the artificial one. Since it has been claimed that artificial models are still incapable of having real-person insight and consequently completely autonomously and critically present and decide upon high-quality architectural design proposals in regard to presented spatial tasks, no matter the number of examples which they have been trained on, the author aimed to document and deconstruct her own design process so

as to determine the main reasons based on which human-controlled processes deliver better results in certain aspects when compared to their artificial (AI) counterparts, as well as how they can be measured, parametrized, and transferred into the algorithmic patterns. Some aesthetic aspects of both approaches will also be examined.

The case study has been chosen from the author's practice. Simple in terms of the programmatic requirements and additionally highly constrained by urban locational parameters considering formal boundaries, this case appeared to be appropriate for examining possibilities of internal morphing and variation based on values defined by the architect herself from both professional and critical perspectives while also following the standard contextual parameters. The study of the design process grounded on architectural plan variability, versioning, and optimization, had a specific focus on decision-making during these operations. Having been of the key importance for determining protocols for the contrasted artificial behavior, the act of decision-making and architectural design intentions have been taken for central concerns within the debate on differences in design performance of humans and machines.

Design options have been documented in an elaborate map-diagram. The applied model utilized the branching logic of variations alongside main arguments that directed their course of development. Through such representational and analytical forms, the complete evolutive footprint of the investigated design and different architectural scenarios have been recorded within a common scene or an image, following dynamic changes and adaptations to the bounding conditions and design parameters toward the final solution that best responds to all of them and to the architect's design intentions. The main objective of the procedure, which can be situated in the field of algorithmic thinking, has been to convert this map into the set of instructions for an artificial architectural plan generator, or, in other words, to determine possible generative formulas in the recorded design process pattern that can properly address spatially expressed programmatic aspects besides the formal and structural features that have up to date taken the dominant position in similar kinds of research.

Keywords: generative design, architectural design, design process, mapping, diagramming, automation, variations, human-machine relations, algorithmic thinking and architecture

1. Introduction

As it has been indicated in the abstract, the presented investigation addresses the problem of the analytical framework for main formative parameters, values and standards, creative inputs and decision-making that all direct the course of design's development within the architectural design process. The

analysis of a process marked by variation places the emphasis on extensive transformations of possible design solutions during the course of the project's research phase and proposals' optimization. Behind the aim to document and deconstruct all the elements involved in a design process and clarify dynamic and frequently unfathomable relations between them, there is an aim, firstly to better understand human constructive and inferring cognitive processes, secondly to compare their logic and algorithmic regularity and irregularity to the existing artificial modalities and behaviour, and lastly apply it in new automated ways in order to test the possible effect and successfulness in terms of quality of architectural designs. Artificial intelligence, having been perceived "as a set of technologies that externalize certain rational and logical qualities of human reasoning" [1], according to A. Bava hasn't addressed all important aspects. Besides the formal logic and the aim of new design methods based on computation in relation to it, those parameters that make architecture "a habitat-making practice" [1] haven't been completely elucidated. In that respect, generative principles and variations have been applied and tested on architectural plans, as well, all towards, once the aims of this effort have been achieved, the better integration between the structural and formal, and programmatic qualitative properties alongside other external features. In order to set the research standards and objectives beyond the pure style (e.g. such that has been claimed through the notion of *parametricism* [2] or asserted by the term *digital style* [3]) and formal-structural optimization, this study will try to add its findings to this other cluster of

inquiries through defined experiments and practitioner's reflections. To that end, having awareness of all precedents - from those regarded as founders of the traditional approaches to this issue in architectural history (e.g. Le Muet, Briseux Durand in [1], but also other architects and architectural theorists devoted to similar problems [4]), across the authors that pioneered or enabled the transition from traditional to digital approaches and modalities in both architecture and arts with specific perspectives in the field of generative design (Alexander, Wurman, Price, and Negroponte, in [5], Doxiadis [1], Molnar in [6], Soddu and Colabella [7], etc.), to those whose theoretical, critical and design research pertains to better understanding of consequences of intelligence, algorithmic and digital turns in architecture [8-10] and the most recent experimentations with neural networks and artificial intelligence in general [11-19] - the specific focus will be placed on interior morphing of the architectural space and programmatic variations within the architectural design process [1, 20, 21, etc.]. The existing publications on *variation* and *versioning* [22-24] have also been consulted, while some of the previously published personal studies [25-27] provided substantial knowledge of relevant references and design research methodologies, establishing thereby conditions for a move from theoretical reviewing to application in practice and experimentation along with original innovative contributions.

Having still been in the first research phase, this open and unfinished project and research attempt will be discussed in terms of its prospects and possible contribution to the existing set of similar

investigations and experiments, all dealing with generative principles and algorithmic variation in architectural plan design. We will be looking for the regularities and irregularities in decision-making during the design process, the main difference between the human and machine capabilities and expressions, the required language of instruction, design protocols, and above all, for the algorithmic interpretation and a map of the analysed processes as a potential input for machine automation.

2. Human to machine/artificial Intelligence

The structure of the analogue design process and decision-making have been mapped and organized to enable easier transition or conversion of hereby documented procedures and out comes to the language of the machines. It has been presumed that through several analytical and refining iterations the material can be properly formatted to correspond to algorithmic machine logic. This relation – between the human and artificial inferring processes, or procedural instructions – has been subjected to scrutiny in the following paragraphs, suggesting in particular graphic ways of doing so.

2.1. Human logic – algorithmic form

By taking into consideration all design-informative and design-guiding parameters that might be constructing the conceptual lattice or framework, the analogue design conduct has been documented and catalogued including all its steps and development phases. The mapping method followed the logic of rhizomatic branching (Fig.1) implicating

openness of each temporary consolidated proposal or probable solution. The first map represents the free course of decisions made in terms of change in variant types, and it shows the attempt to simultaneously lead several parallel processes and variants' adjustments. The second map displays the post-antes ordering, rearrangement, and classification of all produced variants, whose footprint has also been represented through another 3d structure.

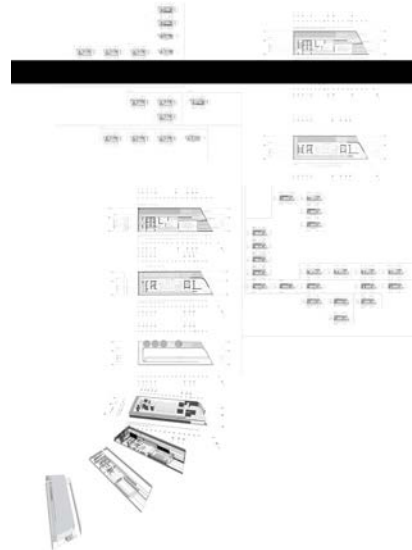


Figure 1.

The 3d model contains variants and their subvariants, along with graphic remarks on specific elements that have been subjected to transformation and representation of these through sequences (multiple phases of development between several kinds of solutions). The graphic intervention leaves spatial traces of branching and thus forms a connecting structure between the variants, solidifying in a certain way the relations made between design options and refinements of each at the smaller interior scale (Fig.2).

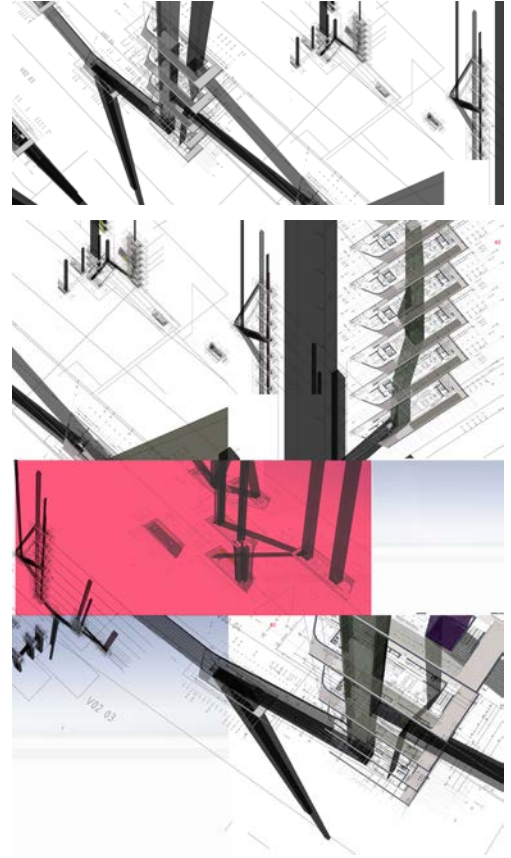
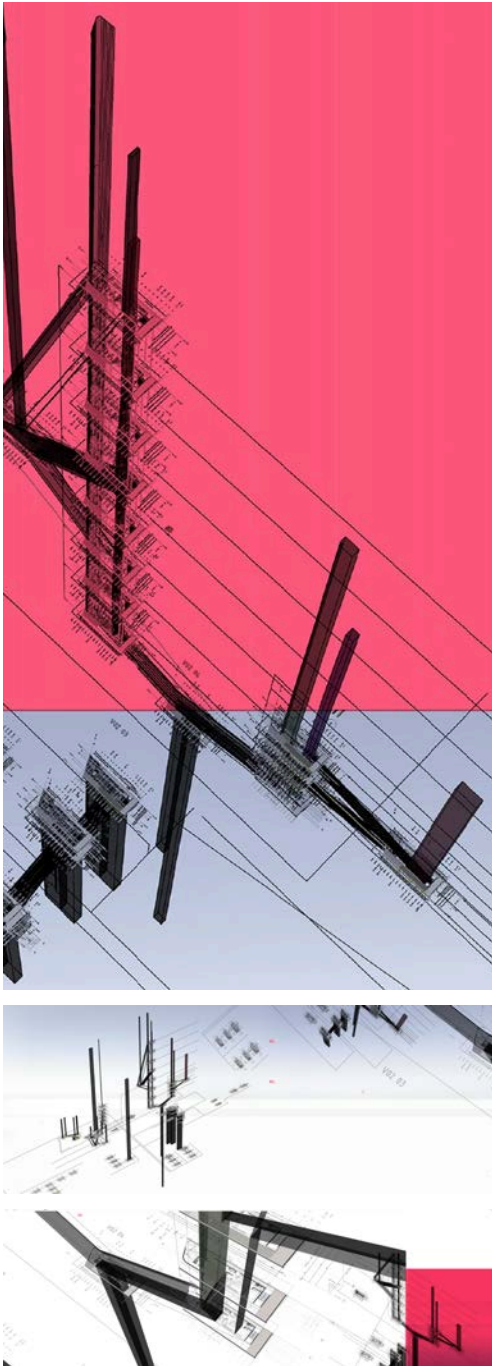


Figure 2.

2.2. Machine logic

In a continuation of the explained plan, several existing variation-based machine algorithms have been analysed in terms of their operation and logic behind the processes they perform. The successfulness of the conversion process rests on substantial knowledge of differences between human performance and behaviour and that of the machines, and necessary adjustments. It has been assumed that the former (human) performance is frequently non-linear, less predictable if left to individual conduct and without the schedule, as well as possibly

inconsistent regarding the strict order and mathematical rigour of the organization phases depending on the course of research and unexpected occurrences. Being also relatively prone to errors and creative changes or interventions, human conduct has been considered as usually opposed to that of machines' clean and simple performance, more easily discerned in terms of the precision or numerical values of parameters by which it can be measured. But such a clean cut between the two cognitive modalities hasn't been the aim of the research and development programs and agendas, even though the distinction tests still trace differences similarly based on everything stated. Such does the Alan Turing's test from the 1950s, originally called *the imitation game*, or simply *the Turing test*.

A number of authors have been interested in the relationship between architecture and machines, considering them to include different forms and varieties of objects that qualify for machine designation (review in Ciric, 2020). Among them, computers and artificial sensory infrastructures have only been some of the most recent ones. Computing and artificial intelligence stand out as the most relevant of all machine technologies in the current moment and for the future of the development of the architectural discipline. As important research areas, the fields of architectural intelligence and design intelligence, architectural artificial intelligence, and neural architecture have finally been given contemporary critical and theoretical support and views [8-21]. In reference to such contribution, navigation within the field becomes much easier.

One particular instance regarding machine or algorithmic operation can be singled out to make a critical argument that will support the research proposed in this report. It has been asserted that machines, or algorithms mostly "learn how to see" - their performance and creative work are based on visual training and parameters they identify through this one sensory framework - but they "cannot learn how to plan" (Del Campo in [19] (1.02.15), or this and other higher cognitive performances still haven't been refined. The semantic or programmatic content and prediction (having been translated into the required language), combined with visual material, parameters and structure, represent important elements in planning or design. And if the *tame problem* (structural and formal optimization) has been resolved, the *wicked problem* (cultural aspects, multisensory observation and experience present in humans, as well their specific judgement, values, assessments, and practice), still hasn't been completely resolved (the tame-wicked problem relation as formulated by Del Campo in [19] and extended through personal elaboration and towards the posed research objectives).

3. Methodology

3.1 Algorithmic performance and human cognitive input

A discussion can be started over the way in which variations have been organized, structured, or selected, and if this pertains to the artistic or scientific approach, as well as if the authorship over the process could be claimed or it represents an external contribution. If the aim is to precisely determine the logic by which human thinking and decision-

making processes have been made, then the course of the variations' development and the rules that have shaped their final architectural design configurations (alongside parameters that introduced or demanded them), would have to be carefully and meticulously recorded with no space for errors or omissions regarding any possible detail. On the other hand, if following the artistic approach, the rigour of mathematical precision might be loosened and left to subjective decision-making apparatus or to "the last word of the artist" (Molnar in *section 003: On View: Hommage à Barbaud* [6]). Randomness or desultory behaviour has long been given great attention, as well as conscious and reasonable thinking and action, referring to the former as something not easily discernible in human behaviour. Both have been present in the design and other creative processes – at times predetermined, at times unpredictably occurring – but the consciousness of the approach taken and its explanation have always been of key significance for claims of original and specific contribution, whether of artistic or scientific origin.

We find similar questions in debates over authorship in cases where both human and machine interventions are present. There is a question of the degree of human involvement when working with algorithms, and that of particular phases in a design and creative process which human intervention is invested in. As it has been simplified "the difference between messing with a program and messing with its results, changing the algorithm or changing the outputs" is what actually makes a major difference and implies the exact place of the

author's intervention within the design process, methodology, and use of available techniques. The noted problem appeared within the field of generative art, but the similar applies to any kind of work with algorithms, especially regarding the most recent conditions related to artificial intelligence and claims of its creative and decision-making autonomy. For these reasons, the process should be well understood and it is eventually the main component that can warrant the specificity of both method and the output, making results and the work itself original and unrepeatable. One more argument could be added in support of such claims and that places the process as design research method at the centre of the resolution of the situation which does not have any more such fixed rules (or prefixed codes) and procedures of transferring data into architecture [22] (p.7). In such conditions, the process is *invariant* in the formula of design as a complex dynamic system – the property of recognition and the carrier of the work's identity.

3.2 Variation

Variation, variety, and uniformity have been thoroughly investigated in architecture by several authors [22, 8, 10]. We also encounter a number of its modalities and related concepts throughout the architectural literature (versioning, evolution, and evolvability being only a few), and it can be stated that the concept cannot be investigated aside from such context and relational approach to its meaning and use. Yet, for the reasons of the text's economy, only some of them will be directly addressed.

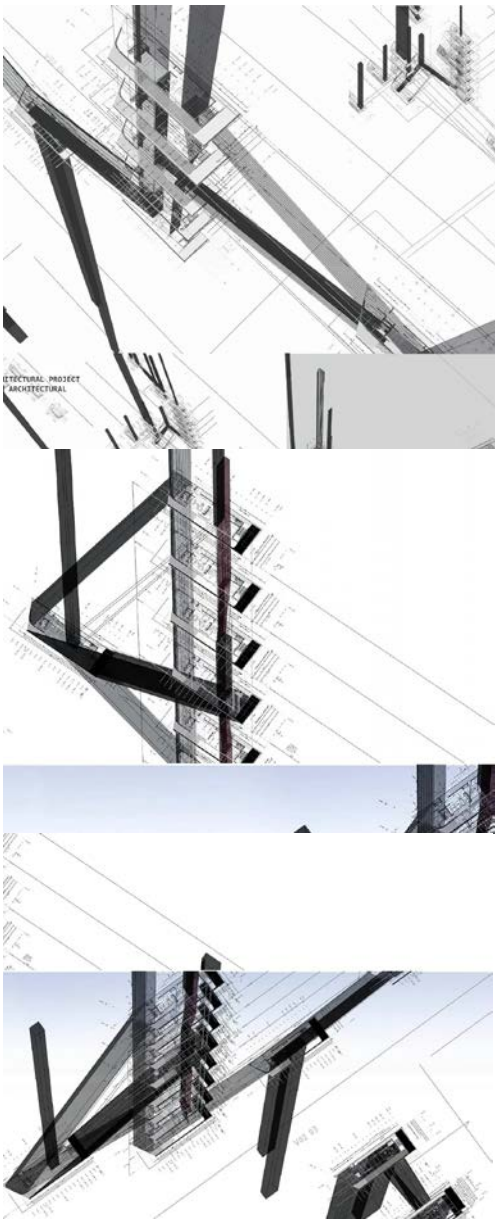


Figure 3

Variation represents a method that implies a design of not only a *single object* but of a *range of objects* [22] (p.7). Multiplicity and difference between all entities within the achieved range

contained in this approach distinguish it from other design approaches. Further on, such multiplicity has its own specific rules that determine the method's identity within the domain of methods based on a larger number of probable outcomes and design solutions. It can be said that they provide necessary deviation or difference which ensures that the solution will be both optimum in terms of predefined requirements (quantified or qualitatively expressed; *extensive* or *intensive* [28] (p.12)) and original/unique in terms of the value it adds as compared to contributions of the existing referential examples and elements it draws certain qualities from. The feature of *irreversibility*, or the inability to return to previous less-adequate or discarded stages while undergoing the constant progressive transformation from moment to moment [29] (p.42), explains the kind of differentiation that marks variation as a specific kind or a class of transformation. Still, the kind of process that has been here described, can retain some of the iterations, return to them, and restart the process from it as another primitive or its evolved variant if the situation implies. Originating from the field of biology or biotechnology (genetics or evolutionary biology), variation and variability are likewise explained in their terms. Morphogenesis has frequently been referred to [28], but the variation that results not only in morphological but also systemic, operational, or anatomy-related transformations and specific outcomes (to use the analogy related to genetic evolvability) is what should be properly addressed when analysing the effects on architecture and architectural design research. In terms of the relational complexity between all the variables and the invariants, as well as capacities that

their degree implies along with results of intricate mutual contingency, it must be said that variation might not always be so easily controlled or known in advance – it usually demands trials, but it also reveals what has been imagined or conceptualized, and can be expected. Its modelling and analysis, however, are at the core of this short study, seeking the best way to explain the variation concept through graphic architectural transformations.

Another feature that is related to digital variations is that almost automatically indicates the design not only of the final product but *the design itself* [22] (p.7) – the *design formula*, or the whole design process and the order of procedures alongside standard disciplinary laws of architectural design. To opt for such kind of a design process and its design indicates openness to external feedback and constant interaction and responsiveness to elements that might affect the process and its object. It also incorporates *perpetual feedback between the analysis, intervention, and exchange with the environment* [29] (p.41) in terms of the very architectural practice. From such perspectives, we can easily infer their references in the theory of complex adaptive systems, or dynamic systems [29] (pp.43-44), and recognize the transfer of such systemic thinking and relations to both architectural object design and the design of a design process.

Versioning appears as another *approach of architects and designers to technology that enables open, gestural, procedural design methodology based on recombinant geometry* [24] (p.132). Such open geometry permits influential (internal or environmental) factors of

formal, programmatic, and structural shaping to “affect the system without losing the precision of numerical control or the ability to translate these geometries using available construction technology” [24] (p.132). The use of “vector-based information over pixel-based simulation and representation” has been advocated due to the fact that “vector-based information allows immediate results to be transformed and refined as the previous tests feed additional data through the framework of intentionality” [24] (p.132). Diverging from the traditional meaning, which implies copying of a type or original, versioning involves variations and evolutions not of one specific source or a prototype but a set of conditions organised in a menu or a nomenclature capable of being configured to address particular design criteria” [24] (p.133). This menu, containing the set of types and specific actions capable of evolving parametrically, represents the primary source of applied transformations - “...design decisions are based on an organisational strategy capable of responding to the change of variables so as to create a fluid movement” [24] (p.133). In such a process the relation between the original or reference and a copy or developed entity no longer exists since the first category has been replaced by the set of attributes of variable value that does not imply any specific object whatsoever, but elements of a certain type, along with possible actions, or capacities.

In terms of the change that variation brought into the sphere of manufacturing, the enabling of mass-customization has been one of the most important ones [11]. It has been claimed that the use of

digital tools to mass-produce variation moved the paradigm from overly criticized reproducibility of uniform and generic solutions towards the be-spoke design and enhanced diversity. This has enlarged the scope of possible answers to architectural design tasks while being much more capable of processing each requirement and constitutive parameter.

The weaknesses that have existed in explained approaches so far have been reflected in the fact that the major focus on variation and optimization has been on formal and structural features, at least to the certain point in time when programmatic and architectural plan algorithms have been more publicly introduced. Programmatic generative algorithms, however, were still either of highly restrictive access or underdeveloped in terms of the all quality requirements expressed by many architects. In addition, some had as their creative goal “the approach to floor plan design solely from the perspective of optimization and without regard for convention or constructability” [21] (also in [20]). The key formative parameters that comprise the system in programmatic terms – the architectural semantic programmatic content – was what has been missing in highly anesthetized and compelling visual results. Not even the narrative or textual inputs available and applied in image-generating algorithms were satisfactory in architectural terms and in terms of a problem of semantic content, and therefore necessary improvements have been required. The spatial configuration of the narrative and its technically literate representation, aside from the geometry and the atmosphere that could have been visually achieved and conveyed, is

what should have been rethought and developed. For these reasons, while all aspects should work in concert, the registered underdeveloped issues have been subjected to scrutiny.

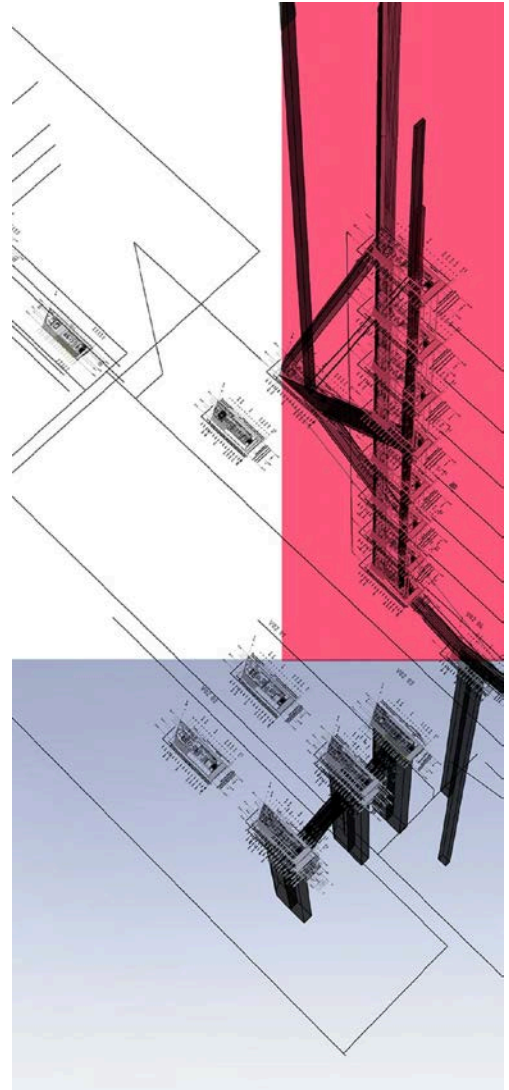


Figure 4

3.3. Process

Documentation of the design process and its thorough understanding provide

the basic material that could be used for the purposes of algorithmic translation. The elements have to be organized in the exact way they have been performed, with a careful notation of temporal determinants. The intervals and successive actions can be further subjected to optimization or different transformative strategies in regard to the design process and its representation, as well as formatted according to the requirements of machine performance as a second cycle of optimization, but at this stage, the correct mapping of the process and variants themselves has to be properly documented.

4. Conclusion

In a conclusion, it is important to assert that the text represents the collection of starting observations and thoughts on the topic. It has been expected that the chosen content will assist in shaping the next phase of the research proposal and in that respect either completely explain the actions accomplished so far, facilitate their understanding while situating them in a wider context of historical precedents, or open up new fields of research and new questions in order to complement and appropriately ground all objectives that have been aimed at. In addition to that, the position that has been taken by the author claims the important role of graphic material, as well, both in the deliverance of necessary proofs and as a confirmation of followed methodology and a narrative of a design process. The illustrations, even though not completely finished, represent a direct reflection of each step of the process analysis and its conversion to the algorithmic mode.

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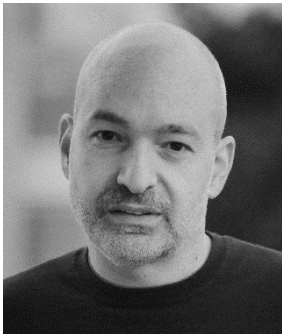
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Xenakis and the Other

Between determinism and the unexpected

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Abstract

Iannis Xenakis, throughout his career, employed deliberately mathematical models as compositional tools. Through those models, and mathematical abstract

thought in general, he sought to break the rules and disrupt the determinism of established musical practices. In other words, mathematical models provided for Xenakis the means towards a freer and at the same time totally unique musical style.

In his quest for mathematically driven composition, Xenakis employed several different mathematical models, both stochastic and deterministic, in a highly personal – and somehow almost cryptic or even mystical – manner. Among those models, one can find his sieve theory, which he developed in the 60s and he employed in compositions like *Nomos alpha* (1965), *Jonchaies* (1977) and *Akea* (1986). Sieve theory holds an interesting and rather unique place in his inventory: It is arguably the most deterministic of the methods that he used, while it arrived in the aftermath of his polemical texts of the 50s, where he attacked serialism - listing determinism and linearity as its faults – and proposed indeterministic, non-linear processes as an alternative. In other words, Xenakis' sieve theory seems to oppose his own, earlier views and practices in a rather direct way. We argue here that this paradox – Xenakis

championing indeterministic methods while using himself highly deterministic methods – is not necessarily true. Or rather, that one must look at the different levels of the process in order to understand where indeterminism is to be found. This realization can inform our understanding of similar issues in the field of design.

Criticism on serial music and deterministic logic and Xenakis' alternative to achieve a balance between musical structures of the past and modern scientific theories.

Many post-war European composers tried to shake off the influence of fascism from their culture and rebuilt and reimagine music, starting anew. Several of them felt that serial organizational schemes of pitches, like Webern's, could be a solid ground for a new music, free of post-war conventions and restrictions. [10] Serial music became more widespread and was studied by many, including Messiaen himself. However, several composers criticized the principles behind serial music, finding them problematic and contradicting. One of the most austere reviews was Xenakis' in his article "La crise de la musique sérielle" [12]. As he explains in his book "Formalized Music", although serial music was utterly deterministic - following indeed a very strict organization of its multiple variants - the aural outcome was incomprehensible and chaotic, or as Xenakis mentions, it was "*an auditory and ideological nonsense*" [13]. His explanations for this paradox, was the serialists' inability to handle indeterminism with the appropriate tools. By failing to do so, they had to resort to

deterministic ones with which they were comfortable. Urging to find an operative framework to cope with this, he proposed to introduce stochastic mathematics and indeterministic ways of thinking in musical composition. More specifically, Xenakis proposes that the composer should employ probability theory and stochastic logic in order to be able to create indeterministic compositions, and most importantly, in order to control their products.

The agents of the "other", the unexpected: Xenakis' use of mathematical models and logic and his ulterior motives for musical composition.

Following the line of thinking developed above, one could indeed argue that Xenakis' concern with serial music was not determinism per se; instead his reservations were more about the ambiguity of the whole process and the confusion that was apparent – at least in his view - in its outcome. For Xenakis therefore, the use of tools deriving from outside music or common musical practice, could pave the way to the liberation of music. To the production of freedom in form and structure that balances between order and disorder, benefiting from both. Without being lost in indeterminism, by missing the essence or by the lack of any logic, while at the same time not being trapped in determinism, by losing all freedom and sentiment.

Serialists, in their attempt to escape past mistakes, appear in Xenakis' view to totally ignore the past; they compose as if older approaches never happened, and try instead to begin from scratch; In a way they attempt to create something

new from nothing, leaving their compositions to chance. To that, Xenakis asserted firstly, that aleatory processes should be calculated. Secondly, that a composer can benefit from past knowledge without repeating it. This is where the element of the 'unexpected', the element outside of the music process, comes into play. On the one hand, although it has been demonstrated that aleatory processes cannot be tamed or imitated, stochastics can ensure ways to navigate through them and hopefully inform compositional processes through this voyage. On the other hand, for Xenakis, scientific and mathematical thought had another, particularly important role to play. They could form the substructure that would support the construction of an original axiomatic musical theory with its ensuing formal structures, that would conglomerate the time continuum.

This past-present-future unification Xenakis talks about [13], concerns in essence the universality that in his view, music should achieve. The universality that, through his eyes, is exactly what serial music lacks. He claims that the "other" (mathematics and logic) could pave the way to a more continuous and global music and replace the linearity and discreteness of serialism.

Hence, it can be argued that the ulterior goal of Xenakis, was not indeterminism for indeterminism's sake, but instead that very same universality of music. With the aid of the agents of the "other", this timeless universality could be realized. To resume, he aspired to create a conception of music that would be global, timeless, open and inclusive, and abstract enough to be applicable to any case, and not simply dependent on chance or pure intuition.

In fact, Xenakis' stochastic music was just a first step towards this direction. The next step was to study the tonal system, which he considered to be the foundation of all music, to understand its structure and transformations and finally to distort it. He attempted to catch the "abstract logical construction" of the diatonic system and translate it through mathematics to a comprehensible, easy to use, global methodology of musical composition and analysis. [13]

It is important to note that the quality of timelessness mentioned before, does not just refer to an eternal aspect of Xenakis' conception. It also means literally "without time" or "outside of time". In fact, Xenakis' approach to musical composition was strongly spatial [7]. He thought that reintroducing spatiality to music could provide the means to achieve his ulterior goals. In "Formalized Music", he explicitly demonstrates that some musical elements or structures that other composers considered to be temporal belonged in the 'outside-time domain'. Therefore, he distinguished musical elements between outside-time, in-time, and temporal, based on their architectural characteristics [13]. Mathematics, as the agent of the unexpected, aided him analyze the relations between compositional elements, their internal structures and the rules that govern them. This way, he was able to synthesize a completely new approach on music, that he trusted it could be a formal and abstract expression of a global and absolute musical conception.

Sieve theory: its role on Xenakis' abstract thought process and the way it managed to break determinism, while being

a deterministic mathematical model.

As mentioned above, the introduction of stochastic logic in musical composition, on the one hand, placed musical indeterminism on a proper framework (theoretical and practical), while at the same time, set up the groundwork for the spatiality of music to flourish and blend uniformly with its temporality. This fusion was essential to create a global, timeless, and coherent conception of music. However, it still did not suffice for Xenakis' ambitions. Since, as we have already demonstrated, indeterminism alone was not the Xenakis' goal. He also aimed to axiomatize and formalize his conception. This is where deterministic, set-theoretical, modular logic, on which his sieve theory was based, was of assistance. Xenakis considers sieve theory to be necessary for the axiomatization of musical configurations.

A mathematical sieve works like a filter. From a set of numbers, only the ones that follow a predefined rule are allowed to pass through. Similarly, Xenakis' sieves can produce series of numbers which obey a rule of his making. A Xenakis' sieve can be conceptualized as a line with points that seem to be randomly distributed on it. However, there is a hidden pattern behind this seemingly random distribution. [4] There is a starting point and then every point is located on an equal distance apart from the points on either side of it. For there to be variations to the distance between the points and break this totally symmetric repetition, such sequences can be combined with Boolean operations, creating the final sieve. Having this simple process as a basis, Xenakis used his sieve theory to study the "intervallic" structure (or the "spatial identities", as he called them) of archetypical music, to

reveal their concealed patterns, compare them and eventually distort and combine them. Hence, using sieve theory as a formal tool, he managed to construct new musical patterns of high complexity that emerged through simplicity and transcended classical patterns. A procedure that while technically deterministic, at the same time it resembles fractal procedures. Therefore, a procedure that even when considered deterministic through a deterministic lens, it surely cannot be understood in a linear manner.

Xenakis experimented a lot with his sieve theory and used it in many different ways, playing games with numbers and exploiting their mathematical properties. At first, it was a formal tool that helped him to analyze the outside-time structures of musical compositions and reveal their "hidden symmetries". [3] An interesting example is the prime-number sieve generator. It was a mathematical procedure that could generate a series (in fact, a cycle) of prime numbers that belong to a certain commutative group, by repeating a simple multiplication pattern between pairs inside that group. The sieve he used for *Nomos Alpha* was created by this generator. [6]

There were times, though, that he only used sieve theory to produce scales and organize musical elements. [2] In fact, many times he went beyond that and combined it with other tools at his disposal. For example, he used stochastics and aleatory processes to produce the basic elements then deterministic sieve theory to organize them in space, and finally dramatized this configuration creating a "cinematic progression in-time. In other words, we could say that he employed a combination of increasing complexity in terms of vocabulary, engaging this

complexity in terms of structure and parametrizing it temporally to add a dramatic effect.

An additional reason why Xenakis thought his sieve theory - and its subsequent axiomatization - was so necessary, was its ability to be computerized or mechanized. Hence, he saw it as a weapon to fight the developing industrialization of music. It is important to note that he was not trying to find a way to escape from this industrialization of music. Instead, he was looking to find a way to prevent its domination over music and try to control it while exploiting its advantages. [13]

Originality: The role of the artist in the analytical process of formalizing and axiomatization musical composition.

It is important to place Xenakis' conception of sieves and deterministic processes in general within the larger context of his compositional process. Until now, we have analyzed how the agents of the "other" helped Xenakis create a coherent, universal and timeless conception of music. Besides those qualities, there was one more that was extremely important for his conception, that we have not mentioned yet: originality [13]. This additional quality changes essentially everything concerning Xenakis' view and may resolve many misunderstandings about his work.

He claimed that he made theories and guides for these theories, but in reality, he did not follow them to the letter. He, essentially, developed tools for analysis and production of music, but the way of using those tools in practice was far from the theory he developed. As a result, many have accused him of creating a

gap between his theories and his practice. [11] This becomes clear when someone attempts to employ Xenakis' algorithm and try to work in reverse: in other words, to begin from a score and try to reconstruct the original sieve that was used to produce that score. Actually, in most of Xenakis' compositions, it is nearly impossible to achieve that. Mainly, because the process has been tampered by the composer - in many cases quite extensively. Therefore, many analysts claimed that his process was either confusing and frustrating or just wrong and incomplete. [6] All of the above have a point to make of course, and in that sense Xenakis' theory might not be complete in analytical terms; it might also not be a way to formalize music - as it was supposedly meant to do. But that view can change when Xenakis' processes are examined in creative and syncretical terms. On those terms, his processes succeeded in breaking the norms and escaping the predetermined protocols. It is exactly this ultimate escape from protocols that can justify the use of deterministic processes and the one that grants access to the originality that he sought after.

In fact, by adding originality to the equation, we might understand things even more differently. Xenakis was always in control of the process while he continuously bended and deliberately altered the results of those models to fit his scope and through his own, subjective, artistic judgement. [9] In that sense, for Xenakis the mathematical and computational models that he used were the means to disrupt the standard compositional processes. They were an element of the 'unexpected' that came from the outside of the musical process and altered it in unique ways. On that level, it is of little importance if the

models were deterministic or indeterministic. What matters is that they acted as agents of the 'other' – the non-musical – that when paired with the musical instinct of the composer disrupt the determinism of standard processes.

By employing agents outside of music to analyze and formalize the process of musical composition, Xenakis manages to understand its rules and laws and thus create new ones that serve his own purposes and aesthetics. But through this process, the rules that he creates are not the most important part, especially regarding the product of the composition. What is of most importance is that through understanding the thought process and the way a composition functions, he managed to reach a point where he was able to manipulate and change his own rules. This flexibility becomes apparent if we compare *Nomos alpha* (1956), where he first applied his sieve theory, with *Phappa* (1975), where sieve theory is not used in a formal way, but in a more intuitive one, based on his experience. [8] In addition, the importance of the artist's intuition is highlighted when comparing Xenakis compositions (like *Nomos Alpha*) with the products of his computer program, which one could argue that are less interesting.

Xenakis conception was in essence a fusion between existing knowledge in music and existing knowledge in science. But the secret of his recipe was that he always added his aesthetic criteria, that could affect the outcome on details, or it could change it completely. With the assistance of the agents of the "other" he managed to change the rules and achieve the universality he was searching for in music. That 'other', the non-musical for Xenakis, becomes a constructor or narratives. Musical narratives, that redistribute what was

already 'sensible' – and are therefore aesthetic in nature – and that ultimately manage to push the limits of musical composition in a way that underlines music's autonomy as a discipline. And there lies maybe the most interesting paradox: it is through the reference of the other, of the non-musical, that music manages to remain autonomous.

Conclusion: Towards a Xenakian conception of architecture

Xenakis' processes and techniques are most valuable for many disciplines other than music too. In fact the example of Xenakis' process with musical composition through mathematical models – both the specific example of sieve theory as most other models that he used – can provide invaluable insight into how similar issues can be faced in the field of design and architecture. Indeed, architecture and design seem to be trapped in a position where they are unable to escape the homogeneity and determinism imposed by the standards of the computational protocols that they use. Bringing into those processes the 'other' – the non-architectural – might be a way to develop non-linear, unexpected architectural narratives that - even momentarily - manage to escape the omnipresent control of digital design protocols.

One could argue that the key motivation of the work outlined here is to study how mathematical logic can be used in creative processes as a tool that does not dictate the artistic outcome but is simply at the service of the artists' intentions and facilitates them to explore their options, expand their horizons and go beyond the normal procedures. But it

goes beyond that. Mathematical logic – or for that matter any ‘other’ that is employed – operates in parallel with the artists’ intentions; on the same level with them. That way it can transcend the creative process – either musical or architectural – and through an affirmation of its nature and autonomy becomes able to produce results that would have been otherwise impossible to reach.

This paper’s focus has been to analyse the example of the Xenakis’ sieves as a tool to create a unified, global, timeless, and original conception of music that could be used as a method to face (or better control) the industrialization of music. Ultimately however, the purpose of this analysis is the prospect of projecting the Xenakian conception to architecture, hoping that it could be used as a method to control digital protocols. After all, as Xenakis mentions:

Sieve theory... is applicable to any other sound characteristics that may be provided with a totally ordered structure, such as intensity, instants, density, degrees of order, speed, etc.... This method can be applied equally to visual scales and to the optical arts of the future.

Xenakis example seems essential, since when bringing outside agents to an artistic composition, like mathematical or digital, there is an impending risk that those agents will impose their rules and protocols on the compositional process. It is, therefore, necessary not to misinterpret the agents of the “other” as a black box that magically produces interesting art. [5] Xenakis understood that, and synthesized a compositional process that benefited from outside agents (both mathematical and digital) to assist him create structures that emerge from the inside, instead of being imposed

from the outside. His process managed to avoid the sovereignty of the outside agents he brought to the process (mathematics), and at the same time, it provided the means to battle the domination of already existing outside agents (industrialization). At the same time, it is important to point out that the ‘other’ - the non-musical for Xenakis, the non-architectural in architecture's case - is not a matter of inspiration neither a matter of legitimization. What comes from the outside of music, or from the outside of architecture, is not a mere stimulus that will trigger creativity neither a universal truth that will explain why things are carried out in a certain way. The ‘other’ is a catalyst, a constructor, that can help each discipline to escape the processes of command in favor of those of autonomy.

In conclusion, if today’s architects want to escape the command of digital design, while continuing to benefit from its advantages, and without replacing digital protocols with new ones (mathematical, for example), a deeper analysis of Xenakis’ process, following the line of thinking that is presented in this paper, can provide a very helpful framework. The way he managed to balance between thin lines separating order and disorder, science and art, time and space, analysis and synthesis and to create a compositional process that does justice to his vision of “arts/sciences alloys” [9], is worth to be further analyzed, translated and projected on other disciplines, like architecture, that struggle with those dipoles.

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Flowing GA naturalness

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The *coldness* is the singer of discontinued humans:
It mitigates the souls,
It sedates the anointers.
Discovering the silence between the curves of time.

Main aim:

Following GA approach, to discover aims and tools of the past in our time fixing in silence a deep impressive medium.

NATURA/ SCIENCE

Nature figures are silent;
A silence to be revealed in
almost infinite meanings

HILDEGARDE de Binged: Nature: discovering a site as Investigation mirror [1]

Leonardo: The Vitruvian Man- Art and Science

The Vitruvian Man is a representation of the ideal proportions of the human body. There are incredible similarities between **the Vitruvian Man** and a medieval illustration from the Liber Divinorum Operum, a writing containing the visions of the saint Hildegard of Bingen. More than 300 years before Leonardo's Vitruvian Man, in fact, Hildegard had already created what is known as **the**

Abstract

Sequence:

INCIPIT: objective, hypothesis, tools, poetic text in opening and in conclusion

1-Nature/Science:

Hildegard de Binged- Leonardo

2-Leopardi-Philosophy+Moral and Natural Works- Pound's Silence -

Redness in poetry: Heaney

3- Precedents of lost generation

Chomsky/Foucault:-

structuralism/deconstruction

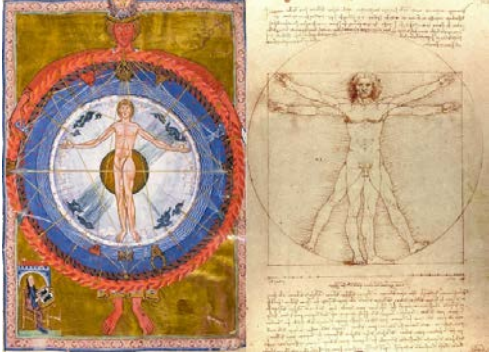
4- Our times -The sound of the earth/ Manaraga

5- From digital to Nft works

6- Lost generations: why art?

Art comes from Nature as site of discovering and mirror of investigation.

Symphonic Man [2] just like the Vitruvian Man, the Symphonic Man represents the ideal of perfection.



"Symphonic Man", miniature from the manuscript "*Liber Divinorum Operum*", I.2, ms. 1942, c. 9r, early 13th century, Biblioteca Statale, Lucca.

Leonardo da Vinci, '*The Proportions of the Human Body According to Vitruvius*', cat. no. 228, Gabinetto dei Disegni delle Gallerie dell'Accademia, Venezia.

In contrast to Da Vinci's work, however, Hildegarde's idea of perfection does not stem from science and measurements but rather from music and poetry. These arts, in fact, are considered by her as a symbolic connection between the philosophical ideas of macrocosm (the universe) and microcosm (man), as well as between God and Creation.

Like Leonardo, Hildegarde was also an incredibly eclectic personage: long before the Renaissance, and at a time in history when women were often considered unworthy of an intellectual and creative life, the saint was in fact a composer, poet, illustrator, philosopher, mystic, botanist and medical theorist. A woman definitely ahead of her time! Who knows what would have been born from the meeting of two such extraordinary minds as Leonardo and Hildegarde?

Perhaps a beautiful symphony of art, science and philosophy.

Word/Gesture

Leopardi: "*The silence is the language of all the strong passions, of love (even in sweet moments), of anger, of wonder, of fear*"

Word is an art learned by men. The variety of languages proves this. **Gesture** is something natural and imparted by nature.

An art:

- 1) Can never equal nature
- 2) However familiar it may be to men, there are certain moments when they do not know how to apply it.

Therefore in the accesses of great passions:

- 1) As the force of nature is extraordinary, that of the word does not reach to express it.

- 2) Man is so busy that the use of an art, however well familiar, is impossible for him.

But the gesture being natural, you will easily see him give sign of what he feels with gestures and motions that are often very vivid, or with inarticulate shouts, tremors, moaning etc. that have nothing to do with the word and can be considered as gestures. Except that such passion will not produce in him the immobility that is usually the effect of great passions in the first moments when he is not good at any action. In later moments, since he is not good at the use of words, that is, of art, yet he is capable of acts and movement.

- 3) For the rest you will always see him in silence. **Silence is the language of all strong passions, of love (even in sweet moments), of anger, of wonder, of fear, etc.** 27 June 1820. [3]

THE HUMAN NATURE

We have to turn to **Voltaire** (1694-1778) and his **Candide** (1759) to realise that we are embedded in the living world whose diversity of interrelated organisms is startling.

A legend tells that **Ludwig van Beethoven** (1770-1827) in search of inspiration **used to wrap a large lime tree with his arms.**

John Stuart Mill (1806-1873) wrote in his essay "**On Liberty**" (1859) that human nature **"is not a machine to be built after a model, and set to do exactly the work prescribed for it. But it is a tree, which requires to grow developing itself on all sides, according to the tendency of the inward forces which make it a living thing."** [4]

POETRY, sonority from silence

"If poetry is not born with the same naturalness as leaves on trees, it had better not even be born".

*John Keats, Letters
1848/21 (published 1848)*

'Silence is all we dread'
Emily Dickinson [5]

This poem consists of a single quatrain:

*Silence is all we dread.
There's Ransom in a Voice –
But Silence is Infinity.
Himself have not a face*

There is something terrifying about silence because it reminds us of infinity and 'Himself' – God, the one who does not speak to us.

Poetry dialogues with silence, underlying it is a music that generates itself slowly and patiently in the text unfolding. Like a sister friend which manifests itself from its underground place to promptly and diligently accompany the text alive in the voice.

"...I have stilled and quieted my soul..." Psalm 131:2

Walter Benjamin [6]

In "*The Metaphysics of Youth*" Walter Benjamin observes: "*Conversation strives toward silence, and the listener is really the silent partner. The speaker receives meaning from him; the silent one is the unappropriated source of meaning.*" In other words, it is the space between words that sets off language. The dim background against which a light becomes visible. For Benjamin, silence was the precondition for a community out of which story arises, and the vast expanse waiting just beyond its inevitable end. Recent collections of poetry fully do justice to this *complex relationship between* silence, narrative, and the tacit relationships out of which language is born. The possibility of transcendence resides in the space between the aperture that gives rise to a "*queer flutter that knocks about your ribs*".

Small Trees

*Small, high-stemmed trees
I wonder if you feel the new pain of the livings.
Among the species mixed without knowledge in cloning,
The ancestral song has broken into the small invisible.*

The mountains have broken their centuries-old mantle of ice
Rivers say goodbye to their ancient banks, drying up in silence.
The intensity degree of the sounds of the universe changes:
Every organicity mutates into pitiful and corrupt eugenics.
Transmigration is not an escape for hope, only fear, fear, fear.
Accepting the irreparable is more painful in the native place.
You little goldfinch slow your lonely wanderings in search of harmonious silence.
Try to stop on a friendly oak branch.
Sing again your song only for children abandoned by their mother's love.
Sing for them; flood their hearts with the deepest perceptible caress,
As only Nature from ever can give to the pure in heart.

Philosophy: the Nature discovering

"Philosophy," writes Josef Pieper, "not only does not in fact serve any purpose, but absolutely cannot and must not serve anything! In the sense that it must not be a particular instrument of any practical activity, but must serve life. To philosophize means to reflect on the ultimate and profound meaning of the totality of what is coming towards us; and this philosophy understood in this way represents an occupation that is not only meaningful, but indeed necessary, and from which a spiritually alive individual cannot possibly be exempted. Philosophy, as a genuinely human occupation, is just as threatened by the totalitarian pretension of the technical-practical world as it is by the nihilistic dogma, according to which the world as a whole is absurd, and everything that

exists deserves to go to ruin, if not with greater at least equal intensity. Perhaps both threats are joined at some secret point of contact. Philosophy like existence itself possesses the structure of openness. Philosophy is a free space, it is the place of listening and silence and in this sense, it is no different from the "contemplation" of which the mystics spoke. The oldest saying that has come down to us from Greek civilisation is still alive, and it is Anaxagoras' answer to the question "For what purpose are you on earth?". Here is the philosopher's reply: 'To observe and contemplate the heavens and the disposition of the Whole'. [7]

"Nature loves to hide itself."

Heraclitus

From Goethe letters to Charlotte von Stein which were sent by Goethe during his stay in Palermo, Italy.

"Seeing such a variety of new and renewed forms, my old fancy suddenly came back to mind: among this multitude might I not discover **the Primal Plant** (Urpflanze)?"

Hopeness- The sound of silence over space/time noise

Seamus Heaney called it redress: repair, remedy, compensation. It is the inner resistance which poetry instils in the soul of its author, a metaphysical outsider. Heaney also referred to Robert Pinsky's words, taken from the essay *The Poet's Responsibilities*: 'An artist does not so much need an audience as he needs to feel a need to respond, a promise to react'. *The Redress of Poetry* is a collection of lectures delivered by Seamus Heaney while he was Professor of Poetry at Oxford University, from 1989

to 1994. In the first of them, Heaney discusses and celebrates poetry's special ability to function as a **counterweight** to hostile forces in the world. He goes on to explore how this **'redness'** manifests itself in a diverse range of poems, from **Christopher Marlowe's 'Hero and Leander'** to **Oscar Wilde's 'The Ballad of Reading Gaol'**. Twentieth-century poets such as **Dylan Thomas and Elizabeth Bishop** are also discussed, and the whole book constitutes a vivid proof of Heaney's claim that **'poetry is strong enough to help'**. [8]

GA Visionaries: Naturalness in Correggio [9]

Correggio (Antonio Allegri; Correggio, 1489 - 1534) was one of the greatest painters of the Renaissance. He did not work in a major centre of Italian art, which is perhaps the reason why Correggio's work does not find such great fame. His delicate feelings, his unconditional joy, the atmosphere of serene calmness that invariably permeates his creations define him as one of the greatest artistic geniuses of all time. Correggio developed a very new model of art, where it is no longer possible to trace the influence of one master or another within it. This new paradigm was totally his own and personal, created solely by his pictorial genius: **"a miracle of art without example"**. In the Dome of the Duomo is almost a zero point, which makes a **tabula rasa** to start again through something radically different from what had previously been developed in the field of art. After this fundamental turning point, none of the canonical elements of pictorial composition will remain the

same as before: **light, colour, movement and action, forms and linear design, the way of expressing feelings, the conception of space**, will be completely transformed. All of Correggio's innovations were destined to change the course of art for at least the next three centuries, that is, at least until Tiepolo, although the influences of his models can even be felt in Courbet. His inventions nourished all Baroque art: Carracci, Bernini, Rubens, drew from him, and from these fundamental ganglia. Correggio's lymph passed into the art of all the others; the entire 18th century, including the international one, was indebted to his pictorial achievements. There was no painter who would not later take his painting **"without example"** as an example, which in its development had no other reference models than his individual genius.



Correggio, Magdalene, from the cartoon for the Deposition in the Mantegna Chapel in Sant'Andrea in Mantua (c. 1509-1511; carboncino, black chalk and white chalk on two sheets of glued paper, 321 x 225 mm; New York, The Pierpont Morgan Library)

A new idea of space: a symphonic space

Only Leonardo with his aerial perspective of **"The Last Supper"** in Milan deviates from the terrestrial perspective used by Michelangelo (except for tromp l'œil at Palazzo Farnese) and by Raphael in Vatican rooms.

Correggio was so loved by painters because of the radical novelty of his idea of space: he was the first painter to completely transform the 'two-dimensional' and terrestrial perspective of the Florentines into a **'three-dimensional'** and celestial perspective.

Leonardo had a certain influence on Correggio, who for this purpose uses a complex and studied *light, colour, and proportional ratios* combination. Above all movement: **the kineticism** of the limbs of his figures fragments the geometric rigidity of the lines of ideal space into *an unlimited number of vanishing points*. The mind can no longer reconstruct and reduce them to a synthetic logic, as is also the case **in Nature**.

Correggio's characters are finally liberated from the constraint of gravity, the necessary link to the concept of terrestrial perspective. They are perfectly in control of the three-dimensional space in which they live and completely free to fly around happily in it, almost acrobats. Correggio arrives at the conception of an idea of space with **a complexity** which had never before even been imagined,

let alone realised. Correggio's space does not look like a rational space but a natural one, which records and reflects what happens in reality, not what happens in the ideal perfection of the mind. To give the greatest impression of verisimilitude to the action, he does not insert all the elements perfectly. Some of them are cutted out, voluntarily and arbitrarily limiting the area of the frame, just as the man's field of vision is limited in reality. In other words, he composes the frame as if he were filming a live scene, in a manner, which is innovative. It is therefore not the staging of a performance; on the contrary, it wants to give the impression of painting an action that is taking place right in front of his eyes, even though to our mind the overall picture may appear somewhat unbalanced.

Naturalness is the fundamental principle that Correggio chooses to adopt, which guides him in all decisions: he reproduces exactly what he sees, even in the study of light, of which he was one of the greatest innovators. However, it is not only the atmosphere of nature that attracts his interest, rather which is released by the delicacy of human feelings. This is the other field where Correggio makes a radical innovation, he refines a never before achieved ability to express emotions, which are always the focal point of his narrative. The representation of movement is the other major field where Correggio makes a radical innovation, there is no painting of his mature period where **action** is not at the centre, and this together with **feeling** does not create a bond between his characters, just as there is no scene in nature where there is no movement. The dome of the Duomo displays the most astonishing concertation of movements,

which has ever existed. Its draperies subdivided into a thousand soft facets, unravelled into increasingly complex folds, are the most direct consequence of the continuous movement that animates them. A perennial agent activity, which in his last works will be increasingly, transformed into wind, fluttering cloths that herald the Baroque taste that was to come.

Correggio is a painter who represents more **what he sees** than what he imagines, caching deeply the complexity of Naturalness.



Parma, Correggio. Dome of the Cathedral: Virgin of the Assumption



Detail of the dome: Virgin of Assumption

Leaves

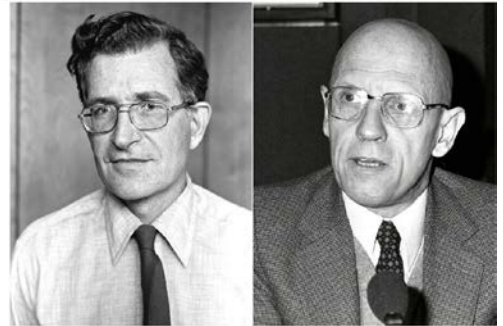
*“Leaves pulled from the forest
They fall in many*

At the first cold of autumn..,

VIRGILIO , (282-284), VI Book“Eneide”

The large opaque elm, which is perhaps the home of vacua somnia, of illusory dreams, attached to the leaves on its old arms of branches

What is human nature Chomsky/Foucault



In the debate (1971), on Dutch TV, between Noam Chomsky, MIT, and Michel Foucault, Collège de France, on the subject of **'human nature'**. Chomsky coherently theorises the existence of human nature, which in his view consists fundamentally - and in this traces back to Descartes (who defines the mind as something opposed to the physical world) - in a creative capacity. This is a faculty that every child demonstrates when faced with a new situation, he reacts to it, describes it, thinks about it in a new way, and which allows him to learn his mother tongue quickly and without learning its rules. It is a *natural, meta-historical* faculty, which grounds our political action against all coercive power:

if this need for creative research (starting with language), for free creation, is an element of human nature, a biological invariant, then a more just society should allow us to maximise the possibility of realising this human characteristic. Foucault, fully denying human nature replies that instead everything is a product of History that in the notion of human nature there is always something regulative, that when we define it we borrow elements of our culture and civilisation. Revealing a Hobbes-like anthropology, he is not interested in defining what man is (his 'essence', definable only in metaphysical terms) but in understanding what can and should be done with man, in this singularly close to Sartre. This approach has led to the profound diffusion of *deconstructivism* in art and philosophy. More than 50 years after this confrontation, in our digital time even dogs no longer bark in respect of the silence of nature! Today we are more than eight milliard of humans. Will the silence still be able to gild the leaves of the elms in our perception of life? [10]

A silence acting

“Take thought: I have weathered the storm, I have beaten out my exile.”
 Ezra Pound *“The Rest”* (1913)

Silence as a vote through an act of will. Ezra Pound's: Vote of silence in the last times of his life. Toward the end of his life, Ezra Pound, 86 old, has found yet another eloquent new voice: silence. This American bard whose *“Cantos”* transformed the language of English poetry... this early champion and benefactor of *James Joyce, Robert Frost, Ernest Hemingway; D. H. Lawrence* and *T. S. Eliot*... this

inspired midwife to Eliot's *“Waste Land”*... speaks now mostly in monosyllables—when he speaks at all. A tall, blonde Austrian sculptor, Liselotte HMI refers to Pound's silence as *“his language of listening.”* Whatever one calls it, though, it has been going on for more than a decade. [11]

“The anechoic chamber”

John Cage composed music, which revolved around silence. Other than his well-known 4'33”, which features a pianist playing nothing for that duration, he was fascinated by silence, as well as sound. Cage famously recounted a story about his visit to an anechoic chamber at Harvard University. An anechoic chamber is one that is designed to trap all sounds made inside it; it is, essentially, the quietest place on earth. As Cage said in his work *Indeterminacy*:

It was after I got to Boston that I went into the anechoic chamber at Harvard University. Anybody who knows me knows this story. I am constantly telling it. Anyway, in that silent room, I heard two sounds, one high and one low.	Afterward I asked the engineer in charge why, if the room was so silent, I had heard two sounds. He said, “Describe them.” I did. He said, “The high one was your nervous system in operation. The low one was your blood in circulation.”
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John Cage famously described the experience: “In that silent room, I heard

two sounds, one high and one low. Afterward, I asked the engineer in charge why, if the room was so silent, I had heard two sounds. The high one was your nervous system in operation. The low one was your blood in circulation.” Originally designed to test loudspeakers for military purposes, the concrete and fiberglass chamber has inspired modern adaptations for commercial music purposes. Mr. Beranek’s advancement in the science of acoustics inspired recording studios, manufacturers and even musical works such as John Cage’s “4’33”.”[13]

Silence power

“The power of poetry able to possess the secret of life says to love in the same way. And of the ineffable role of poetry, which is deeper than life, has our being in its heart, resides its highest expression of existence in what one loves and, understood in this way, becomes, necessarily, the love of one’s being. It is the emergence from shadow and silence of figures of love which for him, as for Éluard, is the energy of language. His poetic reason appeals to the listening of words drawn from the depths in which the silent saying of being gathers.”
Joë Bousquet [13]

The fire silence

Ancient books on cooking fire, an Inflammable prophecy

*“A book is a whole world, which has gone forever.”
.“Vladimir Sorokin, Manaraga”*

The plot of the novel “Manaraga. The

*Mountain of Books’, 2017 takes place in a not-so-distant future where, after a destructive war, technological development reaches maximum progress. Paper is no longer used and this has led to the disappearance of paper books, whose only fate seems to be put under lock and key in museums. Thus, in the new reality, an illicit activity is born, called **book’n’grill**, whose purpose is to recover rare first editions in order to ‘read’ them, i.e. to prepare delicious dishes, using them as firewood. There are only a few specialised chefs and they are all part of a business called ‘Cucina’*

*“From the moment mankind stopped printing books and the best ones turned them forever into museum objects, the **book’n’grill** made its appearance. Men always stretch out a hand towards a forbidden fruit. [...] The first steak grilled that way was cooked in London twelve years ago, in the flame of an early edition of Finnegans Wake stolen from the British Museum. [...] Thus was born the **book’n’grill**, a great passion, which in these impetuous years has turned into a great tradition...’*

Nft: digital artworks

Damien Hirst burnt hundreds of his works after selling them in Nft, ‘Non Fungible Token’. He dressed in silver metal trousers typical of boilermakers and matching fireproof gloves after he collected each work he burnt them in a wood-fuelled fireplace.

Lost Generation silence

*“The beauty of life on the one hand, the expectation of death on the other.” This is how Gustav Klimt painted **Death and***

Life' over 100 years ago. *"In these days we are sliding into a catastrophe of unimaginable proportions because we refuse to recognise the mortal threat".* This the activists said in their several performances in galleries and Museum, using liquid food, glue and black paint on artworks. The group describes itself as *"the first generation to feel the beginning of climate collapse and the last one left to stop it"*.

Admission to the Vienna museum was free on Tuesday 15 November, as part of a day sponsored by the Austrian oil company OMV.

*Il Silenzio di una rondine / A swallow
silence*

*Vorrei abbracciare il silenzio / I would like
to embrace the silence*

*E tenerlo fermo sul mio cuore / And hold
it fixed on my heart*

*Fino a quando la verità emergerà / Until
the truth will emerge*

*E dorerà di luce l'ascolto dei giusti. / And
will gild by light the hearing of the
righteous*

*Torna, rondine, dove puoi ancora posarti.
/ Return, swallow, where you can still
land.*

*La casa è svanita nei sogni degli umani, /
Home has vanished in human dreams
Ma tu ritorni con affetto, in silenzio. / But
you return with affection, in silence.*

*E' luce sulle cose dei ricordi. / It is light
on the things of memories.*

*Ritmi antichi mai dimenticati. / Ancient
rhythms never forgotten*

*Ascolta l'altro, non solo la voce, / Listen
to each other, not only the voice,*

*Ma anche il cuore, in silenzio / But also
the heart, in silence.*

Ending

There is from more than ten years an Internet community that fixes a digital appointment for reading all together each own his/her book: in silence.

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Image from Fibonacci Generative Art Series: Fib_D2_rot-2016

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As architectural students at Technische Hochschule Stuttgart, we could participate in small projects that were judged publicly by a jury of teachers and exhibited a week after assignment. At that time, I was also taking a class on Algol 68, taught by the Director of the Institute of Numerical Mathematics, which was an unusual class to take for an architectural student. As my „design“ for the project „Cafe in a Gorge on the Beach“, I handed in a computer-printed list of around 2500 „solutions“, permutations of a few „key features“ I thought of interest. So, each line in my printout was a sort of „semantic bubble“, supposed to create an image in the head of the reader. No question, I failed

unanimously! But my proposal triggered a remarkable discussion, and towards the end (after a bit less than two hours) one of my teachers (who wasn't on the jury) remarked: „In the end he may be right...“ I think this was the beginning of my lifelong interest in the application of programming to art and design tasks.

At first, it was hard to get access to a pen plotter. It got easier over time, and at one time I had seven of them at home. Then, suddenly, I was the last customer of the last technician in Germany who was able to repair them. (He became very successful later by printing huge formats for hiding large construction sites in Berlin.)

Eventually, one of my Algorist friends suggested for me to go into printing: „The time of plotting is over.“ I was reluctant. Together with one of my former students, we built a large plotter (160 cm x 180 cm), driven by an Arduino board, and with one pen (any type). And I looked into printing.



The displayed piece, *Fibo_D2_rot-2016*, is a print from a series of algorithmic drawings from python programs, to which color (by judgment, not by algorithm) is applied. It is 116 cm x 127 cm and printed on Forex.

Acts for Telematic Painting and Live Coding

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<https://vasileios.github.io>

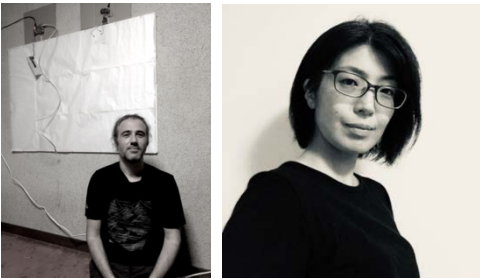
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Abstract

This paper aims to reveal a compositional methodology for the performance work of “Acts for Telematic Painting and Live Coding” with exploration of aesthetic and technical potential of using telematic and sensing technologies. This paper also discusses about composers' strategies for embodiment of audio-visual performance, taking advantage of expanded performing space while comparing with traditional art forms such as calligraphy, painting and several performance styles.

This work is a telematic live coding performance with the application of real-time gestural painting for sound generation, realised by microcomputer and sensing technology. In addition, by means of a telematic technology of OSC communication protocol this work is intended to be performed in remote sites such as

Greece and Japan simultaneously. In this performance it is aimed to explore the novel artistic expression and creative potential that lies between portrayal actions, graphical elements, poetry and sonic events with investigation into appropriate interconnected system structure. This work will be performed by two performers: each has own system that consists of interlinked aural and visual materials, and the work will be constructed through the extemporisational dialogues of drawing (gestures and images) and sonification between them.

One performer uses SuperCollider and the other uses Max, and both try to interpret their gestural and graphical events into sonic events via OSC communication protocol, whilst their mapping strategies are compared on the different sound programming environment.

Introduction

This work presents a multimodal environment that combines gesture with software, computational creativity and technical processes. Our inspiration comes for our interest in cross-disciplinary research such as computational creativity and performing practices. Our experience in multimodal interactive synthesis [4][5] allow us to make the next step and to experiment with other art-forms such as painting and dancing in

order to convey meanings through audiovisuality. Figure 1 shows a snapshot of our live painting rehearsal.



Fig. 1 : A View of Rehearsal

At the same time we investigate the aesthetic and feasible potential of manipulating the sound telematically using performers in a remote space. Ascott in his book [1] about telematics he suggest that the text is the cheaper and easier to process. In this work we use a cheap and easy way to manage data in real time by sharing messages through OSC communication. Additionally, nowadays, the concept of creating systems that can manage telematic technology has increased. There are frameworks in programming environments such as SuperCollider that contain classes that deal with telematic technology and on the fly processing. One example is, SC-Hacks: A Live Coding Framework for Gestural Performance and Electronic Music for SuperCollider [2] which we found suitable to experiment with.

Artistic concept

In this project we present an interactive performance which combines traditional art such as gestural painting and acting (using traditional painting tools and materials) with computer music and electronics. In our opinion this experimental work

can suggest new relations between senses, subjects and technologies.

Our concept is to manage to communicate meanings out of this multimodal composition using symbolism, and with our interpretation to express the significance of a poem's words and to achieve conceptual integration.

We found poetry the most suitable way to convey meanings through symbolism. The poem we chose to audiovisually represent in the Moonlight Sonata by Iannis Ritsos. We decided to poetically relate telematics with the meaning of *the vision of life from distance* that also derived of the poem's meanings. Moonlight Sonata poem deals with the situation of an old woman being alone and intense portrayal of the subject of loneliness and alienation of the uncommitted individual [11].

Thus, we decided to translate the poem's important words that, in our judgement, convey the poem's meaning using symbolism. Our painting aesthetics are inspired by Japanese calligraphy (Kanji symbols). At the same time we focus on sonification of the poem and the manipulation of sound through the movement and gestures.

Additionally, we suggest an alternative - poetic way to present live coding (notation paradigms) by writing/painting on an interactive canvas. In this case our coding language is the symbols that are related to meanings of words and to the code that is responsible for the sound synthesis. The strategy is to use the painting process as the mechanism that triggers the sound by executing the code in our programming environments. In this case the performers can produce the sound by touching and drawing into the interactive canvas and then to manipulate it using gestural symbolism.

In this way the performers can decide when the sound can be part of the overall

performance. While the performers paint onto the canvas the movement of performers can manipulate the sound. At the same time data from performers in remote sites can manipulate the sound. Figure 2 shows the stage diagram of the performance.

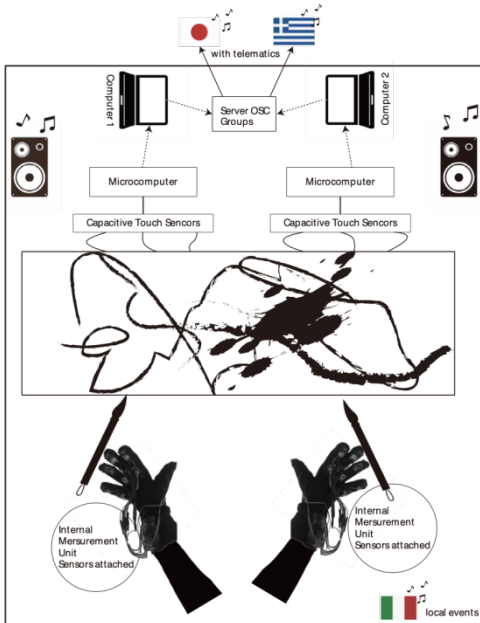


Fig. 2 : Stage diagram of the performance

Our purpose is to sonify movements/actions (gestural symbolism) related to poem's words in our try to communicate meanings. Gestures are important to music as the force that brings life to music [6]. We use compositional strategies to generate products - such as the graphical and the sounding results of performer's actions. We experiment with gestures mappings across domains (real space and mental model of an element).

Additionally, it is possible for the canvas to be reused after the performance as an Interactive installation (performance re-

producibility). The audience can freely experiment with this technology and try with their gestures to poetically reproduce sound that is processed while touching the ink. In this case other algorithms such as chaos and self-similarity among others are evaluating to generate sound [8].

Compositional strategies (plot)

The act is a dialogue between the performers, who paint kanji on the canvas to progressively reveal the poem's broader meaning. Real-time sound synthesis is triggered by the performers' painting on the canvas. The act of painting or writing generates sound that can be controlled telematically (between performers in different locations) by employing gestures as conceptual metaphors. In order to do this, we developed an interactive canvas and used sensors that could detect movement (accelerometer). We use the SuperCollider and Max programming environments to create the sound using computer music techniques. During the performance we can use our live coding libraries [7] to switch between sounds synthesis techniques. We can use various sound synthesis techniques such as additive synthesis, fm synthesis, waveshaping, granular and subtractive synthesis among others. Part of our research is to create sounds that in our opinion are aesthetically related to the meaning of words. For example, the word pain (kanji symbol 痛) can be expressed by harsh noise and the word sorrow (kanji symbol 悲哀) by some frequency acceleration in sustained sounds. At the same time we explore the possibility of manipulating sound using gestures while painting. In this work we focus on *online gestures* [5] for direct manipulation of sound properties. For instance, the motion of the hands may map onto the motion of

the referent (motion-for-motion mapping). For instance, to symbolise the meaning of the word 'sorrow' we can imitate while painting the gestural movement of violinist's bow arm mechanics while he interprets vibrato or whole notes.

The sound aesthetics ranges between ambient/drone sounds and noise so that they can create the atmosphere that is related to the poem's meanings.

Research Focus, Objective, Research Questions

Exploring the aesthetic and technological potential of using multimodal compositional strategies to create sound and generally art on the fly. The objective is to experiment with new environments and expressive methods in computer music and performing practices. We try to extend traditional art forms such as calligraphy/painting and performing using embodiment and telematics practices.

We try to use painting-gesture-sound combination in order to achieve better results in expressing the meaning. Gestures based on iconic mapping as a central mechanism of meaning construction [5]. Additionally, we investigate alternative ways of interaction between performers and art forms.

Designing the system

The design of the system is simple and easily installed. It consists of an a. interactive canvas (embed with microcomputers, and sensors), b. extended painting brushes (embed with microcomputers, and sensors) and c. conductive ink.

To build our painting canvas, we use a sheet of paper that is 1×1 metres on a polymer sheet. We installed onto the canvas sensors that detect electricity

which we translate to numerical values using programming.

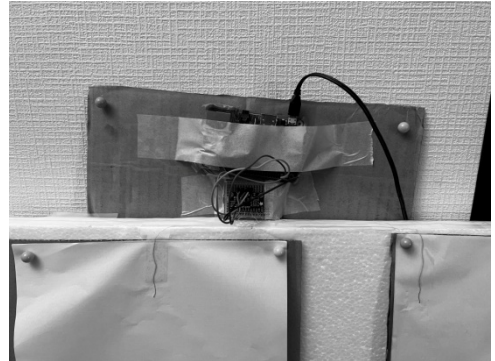


Fig.3: Microcomputer-sensor and wire channels on canvas.

The pins of the capacitive touch sensors are connected with wires that are placed to grooves in the polymer base to keep them stable and separated. This happens to prevent false communication. The wires are also connected with the paper in vertical lines configuration across canvas as seen in figure 3,4.



Fig. 4: Painting in extended canvas

On the middle top of the polymer sheet, we additionally attach the microcomputer (Raspberry Pi) and the sensor (12-pin MPR121 capacitive touch sensor) to a foundation.

To trigger events we paint with conductive materials on the canvas such as

conductive ink. To create conductivity between the canvas and our bodies while painting, we attached conductive material (thread) to the painting brushes as well. The brushes also contains the system that calculates and send movement data to our computer.

We use python code to communicate with the sensor and send OSC messages form microcomputer to our computers. Thus, from the microcomputer we send OSC messages to SuperCollider and Max Msp. We experiment with two different technologies to communicate and send data to our computers. One is to communicate through wifi technology and another one is based on radio transmission. Both systems can respond well in transmitting data from sensors. Then from our computers we can send and receive data locally but also to other remote sites (globally) for instance, Italy and Japan. To achieve this we use OSCgroups [10] and sc-hacks redux [2] SuperCollider framework.

Artistic possibilities of Telematic tech (Discussion)

Telematic technology establishes connections amongst people on earth. It allows collaboration [9] and reproducible research, code sharing, exchanging ideas, rehearsals from distance. We made an effort to metaphorically tie telematics to ideas or meanings like metamorphosis and metafora and to communicate the meanings of poem such as *the vision of the life from distance*. Telematic process depends on the internet and on bad internet connection there is the possibility to interrupt the connection between remote sites. This can cause communication problems during the performance.

Conclusion

Live performances are known for their capacity to spontaneously vary the music with each performance and allow for the unique contributions of each performer to each piece [6].

With the use of technology we can extend the possibilities of expressing ideas using an artwork that consists of multimodal environment such as sound, gestures, graphical elements and data manipulation. Thus, with the use of gestural symbolism, graphical symbolism, sound behavior and acting we can reach an ideal level of conveying meanings.

We combine traditional art with digital technology and internet and we tried to ensure that technology and poetry/aesthetics have an equal influence on the final product and to communicate both the idea/concept but also the technological advantages. Regarding the system's liability we ensure that a. the wifi transmission depends on stable internet connection. Telematic process can have best results when performed on stable internet connection with large bandwidth. If the internet connection is unstable the communication will be lost and as a result to interrupt or to terminate the performance. In the other hand the connected clients of an internet connection can be reduced if we don't use wifi communication between sensors and computer. In this way a stable radio transmission for communication between sensors and computer will be ideal. The radio transmission depends only on stable communication between transmitters and receiver. That means that the ability and the range of transmission depends on their hardware specifications. For example, a radio receiver with bigger antenna can communicate in bigger distances with the transmitter. Furthermore, an internet connection that can be private (network between performers) can be an

ideal option for wifi based communication sensors and telematics.

Future implementation-ideas

A future idea is to experiment with art forms such as experimental theatre, musical, contemporary dance, sculpting among others, and to use computational creativity to test various combinations of modalities as paradigms of communicated meanings and ideas. We also do research in data transmission technology to build a system that is more powerful, liable, cheaper and easily reproducible than their predecessors. We are also interested to add to our system *offline gestures* implementation for gesture recognition purposes amongst others.

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Generative Art from the Calculus Classroom

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Popular tools for producing art with mathematics either tend to centre on design, and require little mathematical knowledge, or focus on mathematics and plotting tools, for example Matlab [1], Mathematica [2], Desmos [3]. The ideas explored here move from foundational mathematics through art, to tell a story about some of the basic concepts taught in a calculus course, including tangents, normal, radius of curvature, level sets and gradients. These explorations should be accessible to people who have not taken an advanced calculus course. We start from a basic diagram of the concept in question, as it might appear in a textbook, and move stepwise from the mathematics to an artistic expression based on an understanding of the concept. The art produced aims to be a playful expression of mathematics,

inviting further thought on both the mathematical ideas and the potential for artistic exploration. In addition, I want to single out simple concepts and show how to enjoy them in their own right, as opposed to the teacher focusing on the goal of use of the concepts, in engineering, medicine, and countless other fields, which may be too distant for some beginning students. Topics can be mastered simply by computing plenty of examples by hand, but not all students will find this sufficiently enjoyable to hold their interest. Mathematics is not always taught with as much emphasis on the creative process as is necessary for the discovery of new mathematics. Introducing visual art may help some students find their path to creativity in mathematics. The humble tangent line is just a very first step on the way to being able to solve important problems necessary in the use of technology in modern life. Sometimes it seems that there is a huge gulf between those who “get it” and quickly move on from the basics to the more advanced applications, and those who never really master the first steps in calculus. The invitation to consume and make artwork based on the basic concepts is an invitation to join the conversation, and perhaps contribute to these fields. Making an artwork based on the first concepts in calculus causes one to pause and savour the constructions. Using art may help students who do not immediately grasp a lesson. Generative

art can help the teacher convey her understanding of and enthusiasm for the topic, and also slow down the presentation, which may help some students. Art can make the lesson more enjoyable, by making the inherent creativity in teaching and doing mathematics more visible to those students who do not at first see this.

1. Tangent lines

The tangent line is one of the most basic concepts in calculus. A beginning text might contain a diagram as in Figure 1, (latex tikzpicture) showing a tangent just touching a curve.

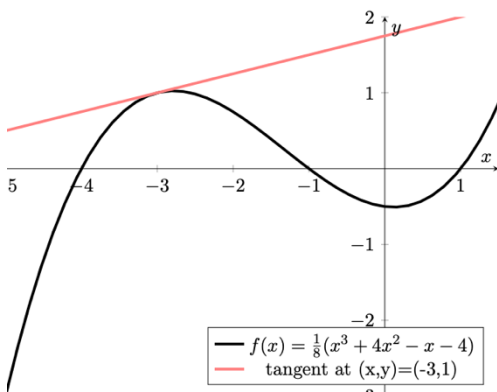


Figure 1: Textbook example: tangent at a point.

The use of tangents in string art is well known [4], for example Figure 2 shows lines forming tangents to a parabola, and Cremona's construction of a cardioid curve (classic 19th century algebraic geometry). Many examples are available in the online program GeoGebra [5]. Tangents to a sine curve are shown in Figure 3 (fixed length) Figure 4 (sinusoidally varying length). Animating the curves and tangents produces even more possibilities [6].

Producing such figures, and predicting the outcome from the equations, could be a good exercise for beginning calculus students.

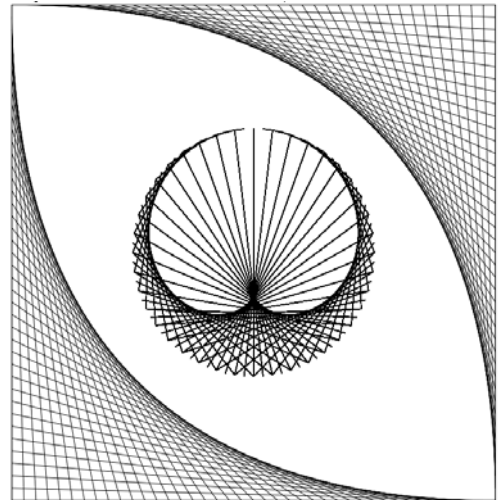


Figure 2: Tangent line string art.

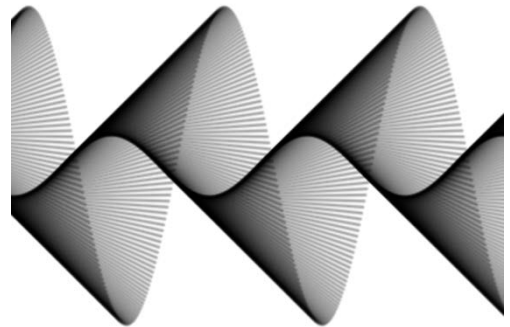


Figure 3: Tangents to $y = \sin(x)$.

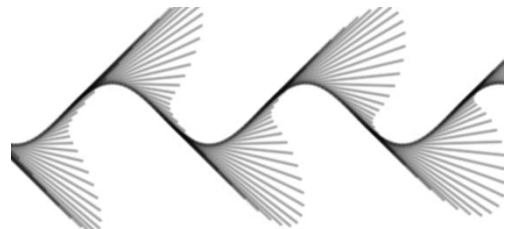


Figure 4: Variable length tangents to $y=\sin(x)$.

Producing such figures, and predicting the outcome from the equations, could be a good exercise for beginning calculus students.

2. Normals

From tangent lines, we pass to normals. The normal vector at a point on a curve is a line perpendicular to the tangent, as shown in the diagram in Figure 5.

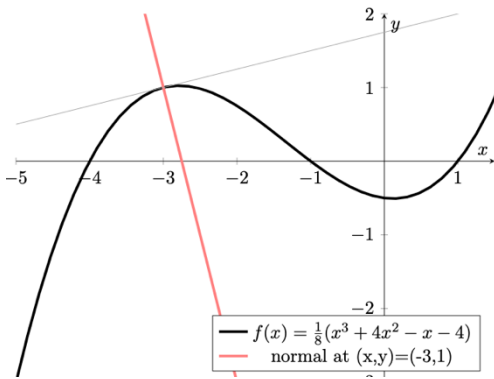


Figure 1: Textbook example: normal at a point.

Normal vectors to the sine curve are shown in Figure 6. The lengths in this example are given by the radius of curvature.

2. Radius of curvature

Whereas a tangent line is a line that just touches a curve, the *osculating circle* is a circle which just touches the curve and is as big as possible without crossing the curve, as illustrated in Figure 7.

The radius of the osculating circle is the *radius of curvature*. Figure 8 shows many osculating circles to a sine curve. The number of circles, their placement,

and distribution will produce very different effects from the same curve, for example, compare Figures 8 and 9. Figure 9 is more “educational”: the viewer is invited to consider which circle is an osculating circle at which point on the curve; this is

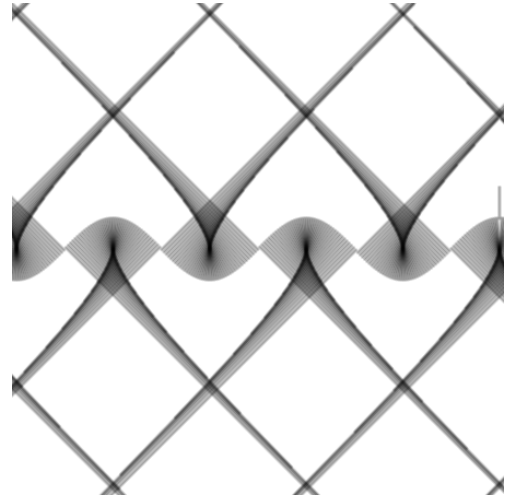


Figure 6: Normals to $y=\sin(x)$.

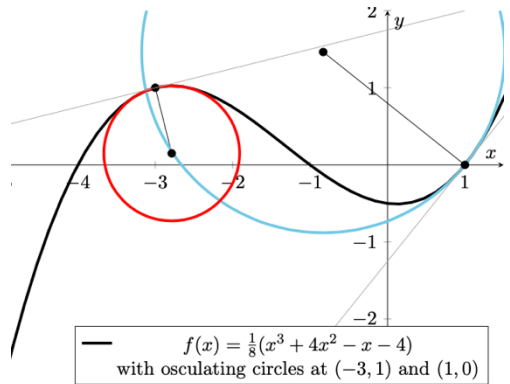


Figure 7: Textbook example: osculating circles at $(-3, 1)$ and $(1, 0)$.

harder to see in Figure 8. Figure 10 combines normals and osculating circles.

The osculating circle has centre on the normal to the curve, at a distance from the curve given by the radius of curvature. P laying around with these ideas, we could draw the circles with the correct centre, but change the radius of the circles, for example, as in Figure 11. Many variations are possible.

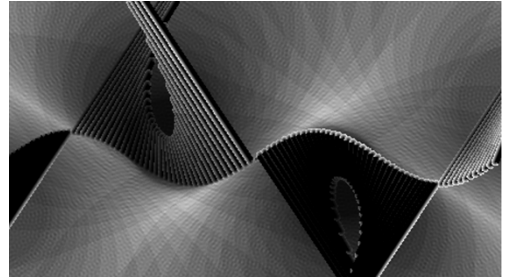


Figure 10: Normals & Osculating circles.

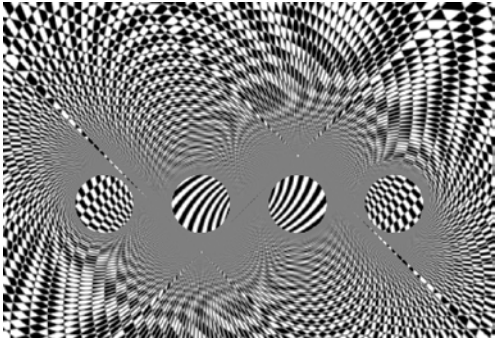


Figure 8: Osculating circles to $y=\sin(x)$

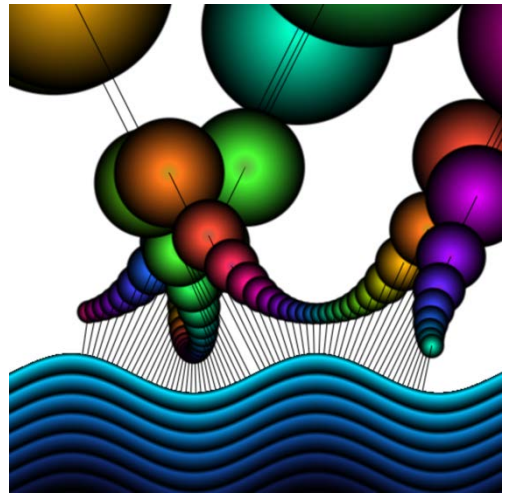


Figure 11: Based on osculating circles

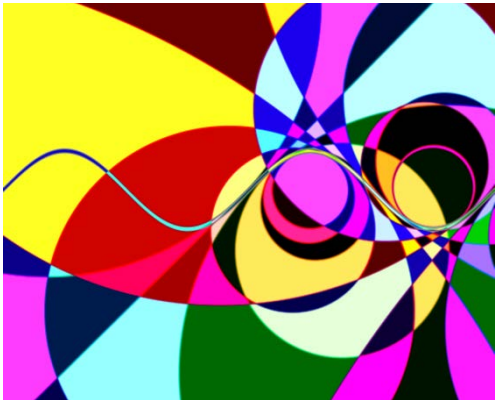


Figure 9: Osculating circles to $y=\sin(x)$.

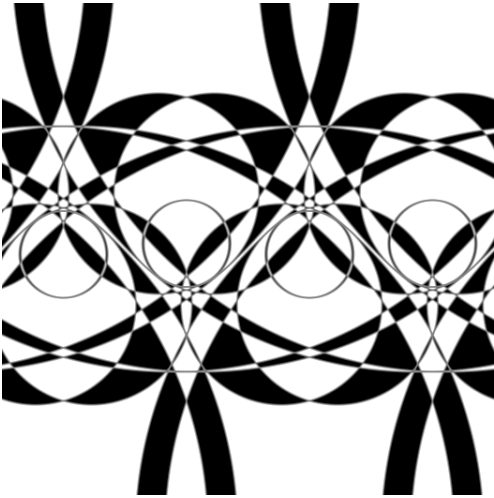


Figure 12: Osculating circles of $y=\sin(x)$

3. Level Sets and Gradient

Two of the first concepts learned in a multivariate calculus class are level sets and gradient. For a function $f(x,y)$ and a constant c , the level set $L_c(f)$ is the set of points (x,y) where $f(x,y)=c$. In the context of maps these are called contours. The level sets form a collection of curves, as shown by the red curves in Figure 13. The gradient is a vector field, that is, a collection of vectors, which in the map interpretation, will point uphill. These are shown as blue arrows in Figure 13.

Further examples are shown In Figures 14 and 15. A vector field is a specification of a vector at every point in the domain for example, a wind speed at every point. But we can only draw a representative selection of vectors.

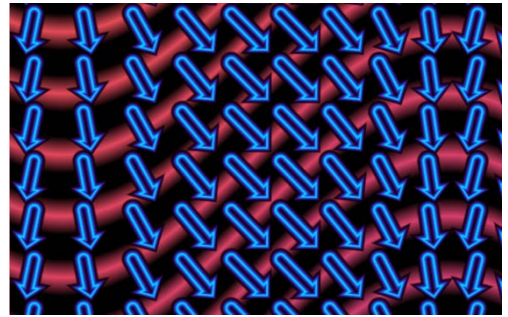


Figure 13: Level sets and gradients

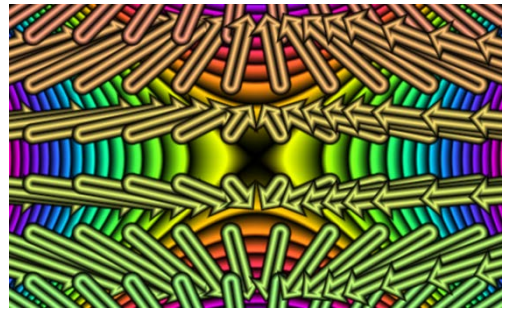


Figure 14: Level sets and gradients



Figure 15: Gradient vectors.

In Figures 16 and 17, the gradient vectors are replaced by lines perpendicular to the contour lines, which are in the direction of the gradient vectors at any point, so produces a levels/gradient field effect.



Figure 16: Generative art from a gradient.

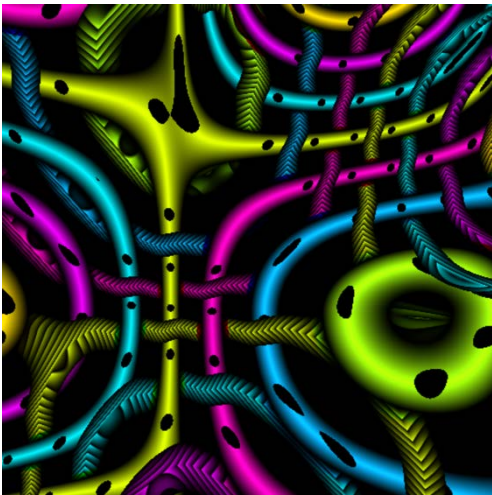


Figure 17: Generative art from a gradient.

5. Conclusion

These generative art works aim to convey calculus ideas in a memorable, non-intimidating way to beginning students. The idea is to complement a standard textbook such as [7] with some light relief, and food for thought. These figures can be animated for enhanced effect. In future I intend to create work based on concepts such as divergence, curl, and theorems taught in a first multivariate calculus course.

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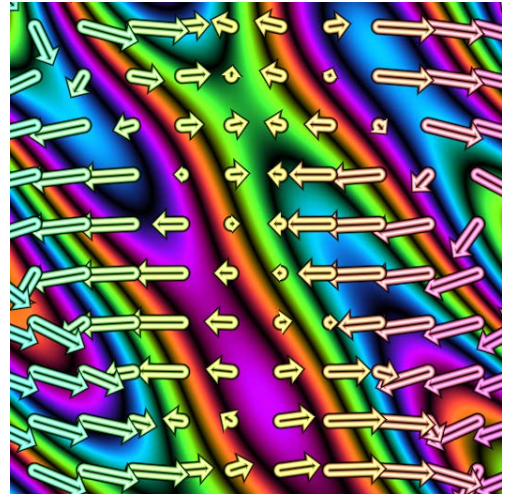
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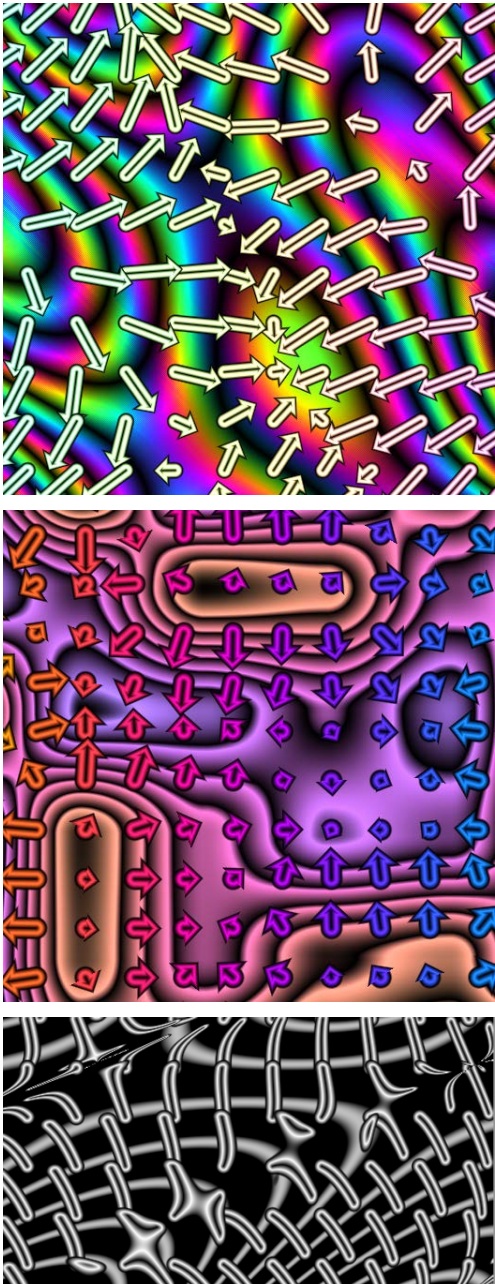
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Figures 18-21: levels sets and gradient examples.

Snake in the Labyrinth

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Abstract

Snake in the Labyrinth is an audiovisual art installation that merges the classic early Snake video game with a maze, presented in the style of early 1990s first-person video games such as *Wolfenstein 3D*. Seen from a first-person perspective (i.e., that of the snake navigating the labyrinth), the visual movement and the music are driven by the decisions made by a deep Q-learning network (DQN). This deep machine-learning network plays a Snake game repeatedly and learns from its failures (i.e., collisions) to inform its future movements. It is part of a series of artworks exploring the use of the process—rather than the outcomes—of machine learning to shape artworks. In the Snake game, the player chooses to move up, down, left, or right and tries to continue moving as long as possible without colliding. In this work, those movements are reflected from the snake's first-person perspective, in a

crude 2.5D style inspired by early first-person labyrinth video games. This crudeness and rigidity reflect the unhumanness of the machine learning process and highlight moments of compelling gestures when they happen to appear in the visuals or the music, as the learning model adapts and evolves. Musically, the movements by the snake trigger changes in pitch, navigating up and down through a harmonic series, moving by narrower intervals and at faster paces as the snake performs better, reflecting focus—a flow state—and a feeling of progress. Conversely, wider intervals and slower passages reflect moments when the snake has not performed well and should reflect on its experiences and rethink its approach. As with the graphics, the music draws inspiration from heavy metal soundtracks for first-person games such as *DOOM*, using custom-coded physically modeled instruments. In all, the work juxtaposes the mechanical and the organic, running and reflecting, repetition and evolution.

Generative Computer Art and the Unconscious

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Abstract

Psychoanalysis has proven to be eminently useful in art theory and practice, yet it seems generative art and computer-based practices remain outliers in this regard. This paper examines theoretical, historical, and contemporary contexts in which psychoanalysis and generative computer art can be brought into dialogue with each other. The discussion highlights how Jacques Lacan's cybernetic reconceptualisation of the unconscious and the Lacanian concept of the real offer ways to develop alternative lines of inquiry that depart from generative art's frequent preoccupation with genetic algorithms and ecological models. Antecedents for this conversation are located in psychoanalytic readings of surrealist automatism and in scholarship on machine art and computer art that implicitly connects psychoanalysis with a history of ideas relevant to generative art.

Contemporary machine learning tools present novel opportunities for artists to engage with Lacan's theory of the unconscious. In an outcome of my studio research, the black box of machine learning is reframed as a dimension of Otherness and fantasy.

The cybernetic unconscious

For Sigmund Freud, the discovery of the unconscious follows Copernican heliocentrism and Darwinian evolution by delivering "human megalomania [...] its third most wounding blow" [1]. This claim evinces a conception of psychoanalysis beyond a clinical treatment and as a radical theory of the human condition in which "the ego is not even master in its own house, but must content itself with scanty information of what is going on unconsciously in its mind" [1]. In his landmark work *The Interpretation of Dreams*, Freud outlines the theoretical basis for an investigative method to gain access to thoughts that have evaded consciousness. Central to this is the notion that dreams are presented as a rebus with the latent structure of intelligible sentences. Above all, the discovery of the unconscious reveals how "the most complicated achievements of thought are possible without the assistance of consciousness" [2].

Throughout the 1950s Jacques Lacan called for a 'return to Freud', accusing

ego-psychology, the dominant psychoanalytic paradigm at the time, of ignoring what was truly revolutionary about Freudian thought. In this context of a return to the radical core of psychoanalysis, Lacan points to a fundamental epistemological shift in Freud's theory at the turn of the twentieth century. Freud abandons neurology, transforming his earlier model of the mind into a properly psychoanalytic one by incorporating informational processes. As a result, the psyche "is no longer an apparatus" but instead "refers to something far more immaterial" [3]. Departing from a theory that localises mental phenomena within human anatomy, Freud transitions "from a mechanical model to a logical model" [3]. Lacan highlights how Freud "discovers the operation of the symbol as such" in the theory of dreams, that is, symbolic processes "working all on their own in the dream machine" [3]. The unconscious is thereby redefined in terms of an abstract machine that manipulates symbols autonomously. For Lacan, the advent of cybernetic machines reified this autonomous symbolic functioning of the unconscious, revealing how symbols "fly with their own wings" [3].

As an illustration of the symbol-processing machine in the unconscious, Lacan refers to a game discussed in Freud's book *The Psychopathology of Everyday Life* [4]. When someone attempts to say numbers at random, Lacan explains, the "associations which then come to him bring to light significations which reverberate so neatly with his remembrance, his destiny, that, from the point of view of probabilities, what he chose goes well beyond anything we might expect from pure chance" [3]. This example has a particular resonance with generative computer art, which has often relied on pseudorandom number generators as a means to the unexpected. The signifying

machine in the unconscious is a determined system, unable to create true randomness, analogous to the deterministic status of a computer program. In the production of dreams, slips of the tongue, jokes, bungled actions, and symptoms, the language of the unconscious involves a ciphering or coding that follows combinatorial rules like those of natural languages which regulate possibilities for combining letters and words.

The real

In *Seminar XI* Lacan addresses the problem of how the unconscious has been misunderstood as reducible to the symbolic [5]. Freud had already written about the navel of the dream, its mysterious central kernel that cannot be deciphered. One of Lacan's major contributions to psychoanalysis consists in the elaboration of this un-symbolizable aspect of the unconscious, which he calls the 'real'. The Lacanian subject emerges in language, "wresting existence from the real that it marks and annuls", yet what the symbolic produces is "in no sense substantial or material" [6]. The dimension of real subjectivity persists and insists as bodily enjoyment at the level of the unconscious. Due to the intervention of the symbolic into the life of a human being, the resulting human subject "solidifies into a signifier" and is thereby divided from itself as an indefinable living organism which is annihilated in the symbolic [5]. *Seminar XI* marks an important moment in Lacan's thought concerning how the unconscious is elaborated beyond its symbolic aspect to encompass the nucleus of the real that does not follow symbolic logic and resists discursive construction, even under the conditions of psychoanalytic treatment.

Slavoj Žižek is probably the most influential scholar who has applied Lacan's concept of the real to a philosophy of techno-science. In *The Parallax View*, Žižek draws on the idea fundamental to psychoanalysis that the human being is deprived of complete access to itself [7]. Crucially, the unconscious is nevertheless phenomenal — it is the way things are really experienced beyond the alienating appearances of consciousness. As Žižek puts it, in Lacan's theory of the subject "I am deprived of even my most intimate 'subjective' experience" [7]. The psychoanalytic unconscious therefore consists in a more radical and more unsettling "decenterment" than the cognitivist account of computational subjectivity in which consciousness is a "user illusion" concealing "blind asubjective neuronal processes" [7]. Žižek points to how psychoanalysis conceives of the human being as colonised from within twice over: on one hand by a "parasitic symbolic machine" (language working 'all on its own' as the symbolic unconscious), and on the other hand, by "the monstrous life-substance which persists in the real outside the symbolic" [7]. The distinction Žižek makes between techno-scientific and Lacanian theories of subjectivity exposes the potential of psychoanalysis as an alternative conceptual and critical apparatus to the prevailing biological, evolutionary, and ecological frameworks employed in generative art.

Surrealist automatism as generative art

Philip Galanter's essay *Generative Art Theory* contains a widely cited definition of generative art as any practice in which the artist cedes control to an autonomous system that determines features of an artwork or results in the production of a

completed work [8]. Accordingly, the field of generative art is detached from any specific tools or historical context and is "as old as art itself" [8]. This perspective invites a reconsideration of certain art historical practices and movements. Surrealism is one example, penitent to my purposes here due to its relationship with psychoanalysis.

Applications of certain surrealist techniques such as frottage and decalcomania could be considered as generative art methods because they allow the agency of material processes to determine features of an artwork. These are reasonably simple examples that conform to Galanter's definition, provided certain physical and chemical processes determine specific aspects of the outcome which an artist is generally unable to predict. These processes would thus comprise a system possessing a degree of functional autonomy from the artist. In such cases, surrealism intersects with generative art without relying on the concept of psychic automatism and a surrealist account of the unconscious. This is important because surrealist notions of the unconscious depart significantly from psychoanalysis — it is rather psychoanalytic readings of surrealism that allow for connections to be made between Freudian thought properly speaking and surrealist generative art.

As outlined in André Breton's first *Manifesto of Surrealism*, psychic automatism is a privileged mode of artistic production dictated by an inner voice ordinarily split off from consciousness. Automatist practices aim to give free reign to unconscious speech, for which surrealists are to become "modest recording instruments" [9]. This conception of a generative art practice may have been original insofar as it proposes that artists are also their own 'external' generative system. However,

Breton does not adopt a psychoanalytic understanding of the unconscious. His implicit claim is that surrealists can, via psychic automatism as a method of generative art, engender an unmediated speech of the unconscious. Breton does not posit any limit to self-knowledge. In his theory of the unconscious, it is possible to merge dream and consciousness “into a kind of absolute reality, a surreality” [9].

In *Compulsive Beauty*, art critic and historian Hal Foster observes how “certain surrealist practices intuit the uncanny discoveries of psychoanalysis” [10]. An important point in this study is that key Freudian ideas, such as the concept of the uncanny, were not directly used by surrealists. Foster also covers a number of ways in which surrealist thought is at odds with psychoanalysis. A thesis developed throughout the book is that “surrealist automatism suggests not liberation but compulsion” [10]. Against surrealism’s celebration of automatist practices, Foster emphasises the uncanny and traumatic dimensions of automatism as understood through the lens of psychoanalysis. In this way, Foster’s psychoanalytic reading of surrealist automatism connects Freud’s theory of the unconscious with surrealist generative art. This raises the question of how contemporary practices might likewise make use of psychoanalysis to reformulate the association between generative art and the unconscious established in surrealism.

The uncanny in machine art

Andreas Broeckmann’s *Machine Art in the Twentieth Century* traces the genealogy of diverse practices that explore machine aesthetics and human relationships with technology [11]. This study provides much valuable analysis of the different fields, movements, and

terms in the history and aesthetics of ‘machine art’ — a term which itself has been used relatively rarely and defined inconsistently. Broeckmann proposes a more robust definition of machine art as “artistic works and practices that implicitly or explicitly articulate the relation between subjects and machines” [11]. An important argument Broeckmann develops is that the ‘machine’ must always be constructed in an artwork: the human subject speaks of a machine, which is not a technical category but rather an imaginary entity that emerges only “in the very instant when it is addressed” [11]. One way this is illustrated concerns a “slippage” found in the writing of computer art pioneer Frieder Nake, whereby the computer becomes a computing *machine* precisely at the moment when it is referred to in an encounter with the human artist [11]. The arrival of the computer does not necessarily entail a break with notions of the machine in art, inasmuch as computers may continue what Broeckmann calls the “myth” of the machine, that is, the machine as “a stand-in for the apparatuses that subjectivate living beings” [11].

By addressing something as a ‘machine’, Broeckmann claims, “it is always already conceived as a partly autonomous and subjectified assemblage”, and furthermore, “viewed as an aesthetic signifier, the machine regularly appears to be intimately tied to the concept of the uncanny” [11]. The persistence of uncanniness in the history of machine art is found across examples in the book from different periods: Bruno Munari’s useless machines in the 1930s and 1940s, Gustav Metzger’s autodestructive art in the 1960s, Harald Szeemann’s exhibition *The Bachelor Machines* in the 1970s, Stelarc’s prosthetic ‘Third Hand’ performances in the 1980s, and Maurizio Bolognini’s *Sealed Computers* in the 1990s. The experience of the uncanny is

thus “part of the aesthetics of the machine whose automatism appears to testify to the involvement of some other agency, or mind” [11]. Despite this prevalence of the uncanny, Broeckmann seems to dispense with Freudian thought rather quickly, leaving out any question of what psychoanalysis can contribute to understandings of the uncanny in machine aesthetics.

As Anneleen Masschelein acknowledges in one of the fullest, most in depth studies on the uncanny, the psychoanalytic conception of the uncanny is the primary focus of a continuing fascination with this concept in culture and theory alike [12]. Broeckmann’s emphasis on the concept of the uncanny would seem to imply the relevance of psychoanalysis to machine art, a field which, via Broeckmann’s notion of the myth of the machine, shares conceptual territory with computer art, and by extension, generative art.

Computer art’s hidden patterns

Grant D. Taylor’s book *When the Machine Made Art* documents the ‘troubled history’ of computer art from its origins in the 1960s through to the 1990s when computing practices became increasingly integrated with the discourses of digital art, new media art and generative art [13]. Taylor points to how computer art was met with antagonism in the domains of both science and fine art, on one hand for its scientific irrelevance, and on the other hand for its “scientific and technocratic heritage” [13]. Within the world of fine art, both humanist and anti-humanist perspectives rejected the computer as “symbolic of modern rationality and instrumental control” [13]. For humanists, the computer dehumanised art, and for anti-humanists, the repudiation of the computer was tied to critiques of technocratic reason. Despite this status

as outcast, within the discourse of computer art itself there was a somewhat hyperbolic celebration of practices that were “the ultimate synthesis of science, technology and art” [13].

Whilst there was an impulse to “privilege the rational”, computer art nevertheless produced its own mythology, which Taylor identifies in the figure of the pioneering explorer, “a figure who explores the limits of the known world” [13]. One significant way in which this pioneering spirit manifested was in the contributions computer art made to fractal geometry, which “demonstrated the computer’s ability to recreate nature’s hidden patterns” [13]. Taylor underlines how models of the natural and the biological became an enduring presence in computer art, and it would seem that the symbolic dimension of human life did not hold the same widespread appeal for computer artists. However, an exploration of the hidden symbolic functioning of the unconscious would appear to align well with the characterisation of computer art as preoccupied with making visible the concealed processes of everyday reality.

In a similar vein to Galanter, who views generative within a history extending much further back than the twentieth century, Taylor writes that “the dream of conflating artificial systems and life can be traced back to Enlightenment automata” [13]. The conceptual underpinnings of generative art discourse are thus linked to the mechanisation of biological life. Although biological metaphors were implicit in early computer art, in the late 1980s the concept of evolution came to fore as a mechanism which could be replicated algorithmically by computers, and which allowed for the creation of potentially infinite and complex forms. Taylor claims that the emergence of generative art discourse is closely tied to the paradigm

of artificial life, highlighting that in the 1990s many artists developed computing practices to explore notions of emergence and “endless excess” [13]. As a consequence, generative art, and particularly computing practices, became associated with the themes of evolution, artificial life, and emergence. This may go some way to explaining why so far psychoanalytic theory has remained largely absent from generative art.

Nevertheless, computer art was theorised in relation to the work of major twentieth-century thinkers outside of science. Discussing the “trend toward criticality”, which appeared progressively from the mid-1980s, Taylor mentions the prominent French theoreticians Michel Foucault, Jacques Derrida, Roland Barthes, and Jean-François Lyotard [13]. Additionally, Taylor suggests the work of Gilles Deleuze and Félix Guattari, who used biological metaphors and notions of the machine extensively, is part of the technological discourse pertinent to generative art and of her contemporary computer-based practices. Given all these thinkers were Lacan’s contemporaries, his absence might seem somewhat conspicuous. As explained above, psychoanalysis was already implicit in the history of generative art via surrealist automatism and the concept of the uncanny in machine art. The lack of direct engagement with psychoanalysis underpins my ongoing practice-led research, which considers what Lacan’s theory of the unconscious might offer to the field of generative computer art.

Studio outcome

The Hole in the Mirror Machine (2020) is a digital moving image and sound work incorporating a series of generative methods, beginning with self-portraits taken whilst I was simulating a state of sleep. These images were converted to

texture maps to generate a 3D terrain such that the contours are determined by image data, with shadows corresponding to deeper areas and highlights to higher ground. The original self-portraits were reused as a final texture layer for the surface of the terrain. The resulting graphical landscape is explored through the flight of a virtual camera, giving rise to anamorphic forms in the terrain as the camera’s movement reconstructs the face or facial features by arriving at certain positions or angles where the forms become recognisable.



Figure 1: Still from 'Hole in the Mirror Machine' (2020). Digital moving image and sound, 3m 35'.

A voice over, produced using a text-to-speech program, accompanies the moving images. The spoken words, along with the title of the work, are taken from outputs of a pre-trained machine learning text generator model (OpenAI’s GPT-2), which was fine-tuned with draft chapters from my PhD thesis in an attempt to reproduce the style and content of my own writing. This speech is clearly a kind of nonsense, though at times it seems vaguely intelligible, resembling styles of poetic language such as outcomes of the Dadaist cut-up technique. The colour and lighting add to an atmosphere of liminality between the zones of sleep and wakefulness, recognition and opacity, and human and machine.



Figure 2: Still from 'Hole in the Mirror Machine'.

The image of one's face in a self-portrait typically belongs to the realm of what is most intimate and familiar. Generative processes in the work manipulate self-portraits, opening the possibility for a shift from the familiar to the unfamiliar and a blurring of this dichotomy. The face transforms into something like an empty sack or a deflated balloon, deformed ears and other parts sprout from a surreal landscape, while in other moments the face is reduced to surfaces of skin and hair without any decipherable features of a human head. A comparable shift occurs with the text: one's own writing can become strange and depersonalised through the computer's generative simulation and in the tonalities of the 'canned' machine voice.



Figure 3: Still from 'Hole in the Mirror Machine'.

The work is principally engaged with the notion that markers of one's identity can be exposed as something foreign or 'Other' by means of autonomous symbol-processing procedures. Central to this is the idea of creative production carrying

on whilst the artist is asleep, or is simulating sleep, as part of the act of handing over control to an external system. This links the generative computational processes to the formation of dreams. *The Hole in the Mirror Machine* connects the autonomy of the computer's role in the art making with how the unconscious manifests as an Otherness that speaks through the subject, such as in dreams or slips of the tongue.

Phantasmatic black boxes

Lacan's famous dictum, "the unconscious is the discourse of the Other", makes his position clear that the unconscious is not simply 'inside' the subject [3]. Rather, the unconscious is governed by an external, distributed, transindividual symbolic order apparent in the operations of speech and language. What this also emphasises is the externality of the subject's most intimate expressions, which rely on a symbolic dimension of Otherness as the locus of agreed, conventional meanings. This is evident in how even the most spontaneous verbal responses take on an inherently symbolic form ('Oh my God!', 'Rats!') within a framework of rules belonging to a given community of language speakers who co-determine meaning ('Ouch!' in English, 'Aïe!' in French), — they are not private, made-up terms. The notion of the symbolic order as an external system is pivotal to Lacan's central claim that the unconscious is structured like a language, which is to say, the unconscious is composed of a chain of signifiers that unfolds according to rules like conscious discourse. Lacan stresses how the unconscious signifying chain "continues to run on beneath the surface, express its demands, and assert its claims" [14]. The unconscious thus entails a kind of automatic foreign speech

which can distort the consistency of conscious discourse.

The *Hole in the Mirror Machine* addresses the question of how generative computer art can make use of Lacan's ideas that connect computing to the autonomous functioning of language in the unconscious. One way this is explored is through the application of machine learning. The GPT-2 text generator model was pre-trained on a large corpus of text (forty gigabytes' worth in the version I used) scraped from the Internet to learn how to produce compelling examples of human language, before it was then fine-tuned to simulate my own writing. Machine learning presents novel opportunities to engage with ideas of the unconscious in its dimension as the Other's discourse, as an external repository made up of foreign material, which may disrupt the experience of consciously constructed identity. For example, by handing over control to the fine-tuned GPT-2 model, my work included text that departs from or contradicts ideas in my research, such as a line at the end which refers to an "installation that evokes a multi-layered story of humanism and technology in generative computer art". In such moments, the influence of the much larger body of 'foreign' text deployed in training the model interferes with the computer's capacity to produce anything I might perceive as resembling my own writing. This reveals how other people's writing, and how other people might speak about ideas in my draft thesis chapters, inevitably occupies a disruptive position in my own work, with the potential to engender conflicts at the level of conscious identity. As the psychoanalyst Bruce Fink puts it, "the unconscious is full of other people's talk, other people's goals, aspirations, and fantasies" [6].

In this paper I have sought to open possibilities for dialogue between psychoanalysis and generative art. In the context of contemporary computing technologies, one direction this discussion may take is to consider how the opacity of computational reality — the hidden dimension of the computer's manipulation of symbols — functions as a phantasmatic space. The Lacanian subject is divided, constitutively alienated from its own being, by emerging within a field of Otherness and fantasy in which symbols take flight on 'their own wings'. This theoretical perspective offers a compelling lens through which to view generative computer art and its defining concept of the agency of external systems.

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City of Memories – City of Voids

Generative Mechanisms within Contemporary Glasgow City

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Wols, *The City* 1950-51

It was the tenement, therefore with its concentration of dwelling, its linear continuity, its intimate relation with the street and its adaptability to different rooms and uses, that provided the connective tissue of the expanding city. And consequently it was to the great damage to the vitality of the city that it was the tenemental quarter that suffered the devastation of comprehensive redevelopment and inner-city highway planning in the 1950s and 1960s. What happened then was a twofold discontinuity, a twofold dislocation: one on the ground, as we move around the city: passing from place to place, and the other in time, in our experience of its history and our part in it.

Peter Reed, *The Tenement City* (2000)

Abstract

Glasgow never aspired to represent the “utopian city” based on an “urban ideal” - rather the visual qualities of the city reside solely in its architecture as it’s embedded within a series of urban matrices. Its Victorian architectural underpinnings are attuned to an individual and subjective reading of the city by its architects over time - as expressed in the multitude of design vocabularies, materials and forms, to structurally formulate and present the identity of the city. Glasgow has over 1800 listed historical buildings. While there are a significant number of historical buildings at risk, only 12% are under restoration in Glasgow.

The city is on the cusp of temporal urban fragmentation as it comes to terms with it’s reflections, memories and voids.

This paper explores the notion of memory and void as a generative design mechanism that double negates the notion of a void and presents an alternate evolution of the city’s identity and its future aspiration. Case studies include the analysis of 4 Victorian architects whose buildings continue to resonate the city’s memory and identity.

Introduction

It can be argued that the 21st century Glasgow's identity is based on an 'image of the city' rather than the city itself. There are multiple instances of the literal interpretations of the past - (Thomson's Buck's Head perched on top of the Building 1862; alongside the phenomenal presence of an absence through the large gaping voids (in the guise of a glass sheet in place of the Honeyman's addition to the Western Club) and multiple urban disjunctions.

Salmon's huge Mercantile Chambers on Bothwell Street (1897) and the astonishing "Hatrack" at 142-144 St. Vincent Street (1899) with a façade less than 10 metres wide, reiterate the memory of the old Georgian houseplots that often determined the form of the building. In Caledonian Chambers (Miller 1901-3) on the other hand continues to reaffirm the urban infrastructure of the city as its inherent identity. The medieval Glasgow Cathedral and High Street with the Glasgow Royal Infirmary (Miller 1901-7) for all its purported demerits, singularly links the medieval Cathedral to the Victorian and contemporary City - laterally through the beaux arts profile of the Queen's Diamond Jubilee Block, overlooking the Cathedral Square.

In every instance contemporary Glasgow retains and thereby generates its image as a memory.

Memory's Images

Memory's images, once they are fixed in words, are erased. Perhaps I am afraid of losing ... all at once, if I speak of it. Or perhaps ... I have already lost it, little by little.

Italo Calvino Invisible Cities (1972)

Alexander Thomson (1817-1875) architectural contributions invite the viewer to look at the city in a critical way, to move away from conventional perceptions and instead embrace ideas that may initially seem remote and fantastical. The urban context is never ignored, rather it seems to evoke an incremental reading of architecture and the city, insofar as it has been perceived with the contemporary city in mind.

His architecture encourages an expanded discourses of the pre-conscious memories of the viewer - with no temporal restriction put in place. The architectural vocabulary is as much embedded within its immediate urban ambiance as it is within the perception of the city as it strives to invent its future direction.

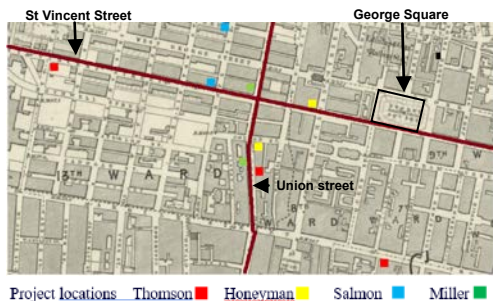


Fig.1 Map of Glasgow 1865



Fig.2 Buck's Head Building as a generative urban scroll.

Thomson's Buck's Head building (1862) composition portrays a holistic discourse on the coeval urban realities and problems. It introduces an important context within the urban space: that of semiotics. There is a distinctive emphasis on the relationship between language, form and a multitude of interpretations and narratives. Thomson's building constantly animates and reinvents itself - at par with the ever evolving urban dictum, through the use of form as an idealized vision.

The Buck's head building includes a series of compositional narratives that support and devise alternate architectural readings of the building. At the outset the facade is a tabeated masonry composition that both accentuates and encloses the corner site within a single rhythmic overlay of glass and cast iron colonnettes that spread across the curved corner. The lower levels rise up to support a decorative wrought-iron balcony all placed in front of the stonework. Here the structure demands the viewer's attention through a number of disjunction - at the outset, there is immense sense of modernist sensibility with the; 'glazing now direct to the iron frame, and so on two storeys, we have a

facade as nearly glass-fronted as possible. At least before the curtain-walling of the twentieth century was devised. The lightness of the frame is abruptly discontinued at the top level, the attic storey, here the iron stanchions are encased in thick, tapering square masonry columns, which in sharp contrast to the slender columns below tend to create a structural tension and divide the building into two horizontal frames of reference: the square columns as they reference the past identity of the site; and the glass-fronted facade as it transcends and animates the structural integrity of the building. This horizontal emphasis within the facade is further amplified by the treatment of the apex of the central facade, which is presented as a 'quadrant occupying three bays of the facade' [1]. The quadrant with its slight off-centre bearing provides an asymmetrical resonance that further accentuates the horizontal play of glass fronted planes, as they animate and attempt to support the upper levels.

The horizontal narrative of the facade as it continues on from the width of Argyle Street to the narrow confines of Dunlop Street creates an added dissonance. Here the design elements adopted are much more 'simplified to provide a vertical emphasis suitable for a narrow street'. [2]

Placed within the historic vicinity of Trongate and the Glasgow Cross, the Buck's Head building both replicated and articulated a series of a design narratives that contextualize the city's ancient streets. These ancient streets - Castle Street, High Street, Saltmarket and Briggate that ran across the length of the city, traced their irregular route from the cathedral down to the river. This historic

axis is intersected at Glasgow Cross by Gallowgate and Trongate. [3]

The Trongate-Argyle Street axis projected the city towards a westward expansion, by the '1840s mansions and townhouses surviving from the eighteenth century had been absorbed into the tight urban structure of the Merchant City'. The myriad of secondary roads and tight closes and wynds that surrounded the Glasgow Cross were also replaced by an 'urban block' configuration during the 1868 and 1877 improvements [4]. The Buck's Head Building typology provides an element of dispersed monumentality that the city at that point in time was experiencing. Here the 'memory in architecture' is as much a socio-cultural narrative, as it is a display of visual metaphors. The building assimilates the site's past identity quite literally at the top level with a large sculpture of a buck's head and attempts to reflect and refract the ongoing urban chasms through its lower levels.

In the Buck's Head Building Thomson attempts a generative 'urban scroll', the top alluding to the past and the lower level alluding to the present, while the central asymmetry of the levels contextualize the site's corner presence within a single cohesive plane. The Buck's Head building in its ability to enhance a void as it overshadows the solid, attempts to generate this new visual logic. Similarly, Thomson's Egyptian Halls (1870) replicates and shrouds itself in its own image. Having been vacant for 40 years and covered in scaffolding for well over a decade, it is considered one of Thomson's masterpieces, and named among Europe's most important, endangered buildings by the Europa Nostra, a pan-

European heritage project.

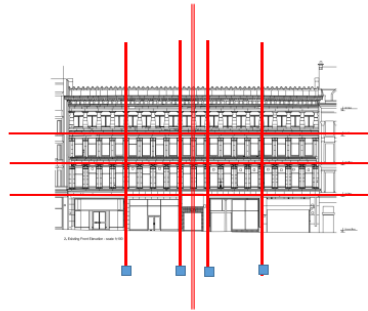


Fig. 3 Egyptian Hall Diagrammatic analysis of the placement of the cast-iron lamps placed in front pavement of the building as inherent coordinates for the building.

Its depleted state has now become a space where the viewer becomes a reader, who must enter, wander round, maybe lose his way in, and then eventually find an exit, or perhaps even several exits, or maybe a way of breaking out on his own [5] - while the physical construct of Egyptian Halls is transformed into a memory etched in words and devoid of its urban semblance.

Memory is Redundant

'The city is redundant: it repeats itself so that something will stick in the mind' and Memory is redundant: it repeats signs so that the city can begin to exist.' The association of these two different notions implies that the cognitive perception of the city can result from the redundancies of signals, behaviours and memory.

Fernandes and Silva, From Moore to Calvino: The invisible cities of 20th Century planning (2014)

John Honeyman (1931-1914) on the other hand presents an urban discourse where architecture is streamlined within its urban bearing. His architectural compositions are based on

agglomeration of urban mechanisms and infrastructures.



Fig. 4 The F & J Smith Warehouse (Ca'd'Oro Building), Union Street/Gordon Street 2022

Placed at the junction of Union Street and Gordon Street, Honeyman's design for the F & J Smith Furniture warehouse (1872) is situated in close proximity to the iconic commercial warehouse of its time, Alexander Thomson's Egyptian Halls (1870). Presumably inspired by the Palazzo Santa Sofia (1428-1430) or the Ca 'd'Oro on the Grande Canal, Venice, the warehouse was built using triple-arched cast iron frames with masonry arches above the ground level. The warehouse was designed with a tall ground floor of big arches in solid masonry and cast-iron and glass façades to the three floors above, each bay being triple arched on slim shafts rising through the first and second floors to circular third floor windows in the panel above them. While the composition is emblematic of a Venetian Gothic palace, the ground floor detail is High Renaissance/Mannerist.[6]

The Ca'd'oro building by virtue of its placement at a junction, triggers a promenade, where recollection and the memory of past events create maps of relationships and spaces through which

to wander. The building with its large glass panels dematerializes into a tracery of its silhouette and constantly transform the viewer's perception by real and imagined events. Strolling across this junction instils nostalgia for an urban narrative that is redundant. The building thereby takes on the role of a reference point for collective history. The significance of Honeyman's architectural intervention and the need for its continued retention as an urban reference point is best articulated by the French anthropologist; Marc Augé (b.1935), who argues that:

...never before has individual histories been so explicitly affected by collective history, but never before, either have the reference points for collective identification been so unstable. The individual production of meaning is thus more necessary than ever.

Hypothetically the Ca d'oro building is already in an ambivalent and precarious state, as Honeyman architectural vocabulary was conspicuously and as a matter of norm, linked to its immediate context - in this case Thomson's Egyptian Halls. The presence of an absence of the Egyptian Halls, presents a violent stitch in the urban identity of the place, and inserts a discord within the design narrative. The city in this instance is incapable to narrate 'its past, but contains it like the lines of a hand, written in the corners of the streets, the gratings of the windows, the banisters of the steps' [7]. While the Ca d'oro attempts to simulate an urban ambiance, its proximity to the motionless preserved image in the guise of Egyptian Halls, divides the urban narrative between the organic evolution of the site and the misplaced and redundant memories. In similar manner the now demolished Honeyman's Wing (1871-74) site on St

Vincent Street presents a semiotic fissure. Here all traces of the addition to Hamilton's Western Club are eradicated and in place a glass structure is inserted, which comes close to the definition of a 'non-place, i.e., a space that cannot be defined in terms of identity, relationships and history.'[8]



Fig. 5 (a) Honeyman's Wing. (b) Glass structure in place of Honeyman's extension of Hamilton's Western Club.

Divided between nostalgia and contemporary urban needs, the above site disconnects and breaks away from the continuity accorded to it by Honeyman's addition Hamilton's Western Club.

James Salmon Jr (1873-1924) architectural compositions explore geometry and fragmented forms in a division of planes that reveal the aesthetic influence of cubism and futurism. His architectural compositions emphasize the cognitive perception of

the urban space. St Vincent Chambers or the 'Hatrack', St Vincent Street (1898-99) presented a dynamic sculptured form, that was set on a narrow and restricted site.

Here Salmon's expertise in modelling from his Art School days, is equally relevant as his architectural finesse. Salmon partnership with the sculptor Francis Derwent Wood (1871-1926) expressed a unique amalgamation of form as it contoured into an ornament or vice versa.



Fig. 6 Salmon's drawing of the Hatrack Building displayed at the annual exhibition of the Royal Glasgow Institute of the Fine Arts in 1900. The Hatrack + Detail August 2020

The façade was conceived in two stages, the original Dean of the Guild drawing, shows a gabled façade with two bay windows. The redesign of the top as an interesting semi-octagon or hexagon was a brilliant after thought.[9]

To achieve the maximum amount of glazed area to the street, the building included a cantilevered steel frame construction, this transferred the loads from the façade and the floors to the H-section columns based entirely within the building. This paved the way for the elevation to be devoid of all structural weight, which allowed the 'stonework to

be whittled to the minimum, thereby permitting the glazing to be held within a thin skeletal stone frame'. [10]

There is no distinction nor divide between where the building begins and the ornament formulates. Both the form and the sculptural and geometric details reduce as the building soars above to its full height. The upper most level is enshrined in a spliced semi-octagonal tower with rhythmic concave and convex planes leading up to the solid void dichotomy in the shape of the attic windows - the pinnacle is almost reminiscent of a lighthouse typology.

The rhythmic treatment of the façade is further accentuated with concentrated rings of the wrought iron work and stairway and rooftop railings, and instils a sense of dynamic and weightlessness, again reminiscent of a lighthouse tower above the sea.

While the Hatrack animates its sculptural bearing, Salmon's Lion Chambers (1904) - despite its depleted condition, constantly ensures that the site is animated and the viewer revolves around the constricted plot. Designed for a Glasgow lawyer and politician, William George Black (1857-1932), the Lion Chambers brief included a block of offices for an exceptionally narrow corner site at the junction of Hope Street and Bath Lane.



Fig. 7 Lion Chambers 2022

The building was envisioned quite literally as a study of cubist forms, Salmon extensive time at the Glasgow School of Art and visits to the central European cities, proved an incentive to initially integrate materials and forms within a single architectural vocabulary, and laterally; deconstruct the complexity of the form into its bare minimal geometric essence. The Lion Chambers comes under the second mode of study.

The project was developed in reinforced concrete and took approximately three years to be executed. Salmon and Gillespie worked in collaboration with Louis Gustave Mouchel (1852-1908) founder of Mouchel, one of the country's largest engineering consultancies, to design the structural system, and appointing the Hennibique Contracting Company of Leeds to execute the construction work.[11]

The building was developed with all load bearing columns and beams, allowing the walls to be free of all load bearing responsibility externally and internally. The outside walls and inside floor slabs are 4inch (about 100mm) thick. Which means there was no space for insulation installation. The load capacity of the building is entirely reliant on 21 columns, beams and floor slabs.

The resultant building rises up to 90 feet, or 100 feet, if the basement is taken into consideration. Built around a structure of 21 columns, each one starting 13 inches square, tapering to eight inches at their summit. Again creating a balancing act internally, through geometrical composition. The loads from the cantilevered floors are transferred via this column arrangement to a raft foundation at basement level and stabilizes the structure across the whole site.

Interestingly the external form at the street level deviates from the minimalistic context above and includes 'roll mouldings at the windows, borrowed from 'The Hatrack' and a group of mock corbels at the fifth floor level'[12]. The function of these mock corbels is decorative and visual dissonance purpose only, as they do not support the overhanging floor. Salmon emphasizes their lack of function through the elaborate carvings of the corbels - an effect which Venturi would have referred to as a 'perspective by incongruity'[13] here Salmon not only changes its meaning but also introduces an alternate semiotic discourse on its validity as an established architectural design element. The mock corbel then becomes part of the cubist forms hovering over the elevation, superimposing within the phenomenal transparencies of the site and the architects perception and memories - with the building dematerialized into a single paper thin dimension, that concurrently accentuates its soaring height.

This sense of dematerialized form is further pronounced on the north elevation, which takes on the guise of a glass façade, due to the use of elaborate glass grid of windows. Its functional significance lies in the ability to instantly flood the internal confines of the building with daylight, and aesthetically reinvents the formal composition of the structure from solids to a series of shapes afloat within the voids accentuated.

Both buildings project generative urban mechanisms; the Harrack laterally across St Vincent Street, and Lion Chambers in concentric circles.

Salmon's buildings introduce a new

discourse on the image of the city as a preconscious reflection.

The image of the city in James Miller (1860-1947) architectural discourse comes closer to the early twentieth century design sensibility associated with the Suprematists. His buildings do not reproduce objective elements of reality as accurately as possible but rather present an implied depiction of grandeur and form - the Union Bank (1924) presides empirically on St Vincent Street with an effigy of a side elevation.

The Union Bank was designed as a monumental public structure and an efficient office building, in line with the wishes of its client. Modernist vocabulary was interspersed within Classical design dictum to develop a structure that would highlight its regional stature and inherent presence within the city.



Fig.8 Union Bank. (a) Renfield St to Union St. (b) St Vincent St to Blythswood Square. (c) St Vincent St leading to George Square.

Situated on the junction of St Vincent Street and Renfield Street, the principal form of the building is best understood as a breakdown of design elements, part-to-part and inside-to-outside context that allows it to establish a complex interchange with past architectural vocabularies and future design heritage. Miller re-conceived architecture as a diagrammatic interpretation of the urban fabric, it acts as a central nodal corridor and links two principal arteries of the

cities: St Vincent Street as it projects its bearing through Thomson's St Vincent Street Church and cuts across the urban milieu to culminate at George Square, and; Renfield Street, as a single continuum between Jamaica and Union Streets as they merge and culminate into Renfield Street.

The building's typology, its Modernist Classical style constructs a link between Thomson's St Vincent Street Church, and the quasi Modernist neo-Baroque architectural philosophy of George Square. Miller's Union Bank also directly contextualizes and enhances the link between his earlier 1903 building at the corner of George Square and Queen Street - The Olympia House. Miller here constructs a series of geometric figures that form a type of subtle, abstract, airy and weightless city. His building contemplates with fascination, its own absence.



Fig. 9 Caledonian Chambers, Union Street to Jamaica Street

The Caledonian Chambers is an alternate example of Miller's work ethics and systematic methodology of determining a design solution that presented an architecture with a strong urban confluence: almost acting as an urban fabric with the building's base used as a warp, and its vertical treatment a

weft, his building incorporated modernist design sensibility within the city's urban consciousness. Situated in the commercial heart of Glasgow's Union Street, the Caledonian Chambers asserts its presence through its dramatic jump of scale, enveloping an expansive block: the building incorporates a pedestrian entrance to Central Station, [which Miller was then remodelling] and inserted a modernist mega-structure within a group of iconic late Victorian assemblage - without in effect disrupting the street's urban consonance.

Miller's buildings resemble an infrastructure of engineered spaces, irrespective of the scale or the client in question, his design vocabulary was oriented towards an alternate reading of an architecture as monument. In the design of a monument it is often the case that the number of architectural elements at play is fewer than in a building, thus requiring the formal devices in play to be all the more precisely tuned [14].

His buildings act as vectors with porous boundaries that direct and formulate new contexts and relationships as the city continues to evolve. The multiple contexts embedded within each and every single one of his architectural projects provides a generative mechanism of the said building as an inherent part of the city's topology and identity.

He thereby constructs a series of geometric figures that form a type of subtle, abstract, airy and weightless city. His building contemplates with fascination, its own absence.

Conclusion

Glasgow is a city of dissonance, its strength lies in its ability to constantly intervene and invent its identity and incorporate new structures, materials and design sensibilities. The architecture of the city is based on individualism; on subjective design sensibilities, expressed in abstract forms and the use of innovative new building technologies and materials. The juxtaposition of design vocabularies over the centuries, forms part of the city's aspirations of harmony with its topography and history, between improvisation and premeditation, between beauty and the mundane, between built and the void.

Sartre (1905-1980) said of Wolfgang Schulze (1913-1951), the artist known as Wols, that he tried to "see the Earth with inhuman eyes". *The City*, blurred and drawn randomly and impulsively, in a frenzied manner, is painted with a mixture of techniques. Wols's tangled city seems light and a passing semblance of itself. Devoid of growth, it seems to have a life of its own, as if it continues to consume itself.

It is a reflection of what Glasgow has become.

Contemporary Glasgow speaks in voids and depleted structures, it makes no sense to divide the City into the past and present, but rather into a generative urban mechanism, that through the years and morphologies continues to give it form to desire, and that in which this desire either erases the city or is erased by it. [15]

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The Use of Markov Chains in Ex Machina

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Abstract

Ex Machina is a multi-disciplinary work combining composed and algorithmically generated music, processed video, and modern dance. The work is a concert-length performance, a spectacle of sound, light, and movement. Inspired by themes in novels by Philip K. Dick and William Gibson and others, ensemble performance is integrated with computer-generated music, video, and dance, generating interplay between real and virtual worlds, between grittiness/immediacy of daily life and cyber fantasy. The work is a musical, visual experience embracing technology and celebrating performance.

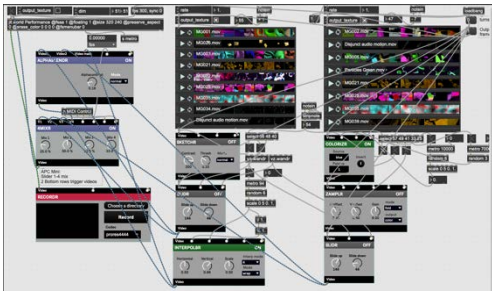
Several movements of *Ex Machina* are generated by Max/MSP patches generating progressions of chords or sequences of melodies using Markov chains. Markov chains generate variations of musical content, ensuring that it is similar but never the same. Video elements are mixed live by a VJ;

they incorporate text from Donna Haraway's *A Cyborg Manifesto*, Baudrillard *Simulacra and Simulation*, and *The Conspiracy of Art* and videos of biomorphic shapes and lines. Time-based processing (e.g., interpolation) is used in conjunction with mixes of multiple video channels. The opening of *Ex Machina* signals possibilities suggested by Haraway: "By the late twentieth century, our time, a mythic time, we are all chimeras, theorized and fabricated hybrids of machine and organism; in short, we are cyborgs. The cyborg is our ontology; it gives us our politics." [1]

Ex Machina Structure

Ex Machina is a seven-movement multi-disciplinary work for electric guitar, drum set, fixed media, live audio and video processing, and dance. The work uses Ableton DAW for audio playback and live mixing; and Max/MSP for video playback/mixing, and for generating MIDI using the Max/MSP Markov object. The work alternates computer-generated and composed instrumental music in sections 1, 4, 6 and 2, 3, 5, and 7 respectively. MIDI information generated by the Markov object in sections 1, 4, and 6 is routed through multiple synthesizers and signal processing in the DAW. We will limit the discussion to musical material and the use of Markov Chains in the 1st and 4th sections of the work after a brief discussion of the Max/MSP video patch.

The video patch (Ex. 1) employs four channels of video information mixed using a launchpad controller. Max/MSP Vizzie objects process and mix video clips. Some patch elements may be controlled by random objects using scaled values or a random walk (vz.wandr). This patch is used for the entire work, with each section using a subset of the clips from the two playlists.



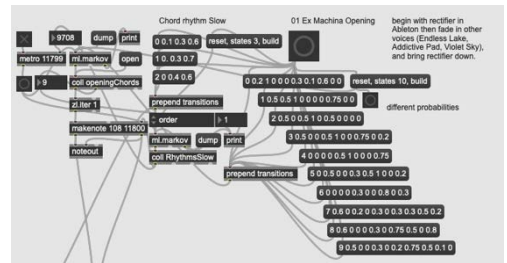
Example 1: Ex Machina Max/MSP video patch.

Ex Machina Section 1 is a pre-show running for 5-30 minutes before the ensemble performs; it is the work's preamble. The videos integrate text from Haraway's *Cyborg Manifesto*, with clips of biomorphic shapes, processed with time-based frame smearing/delay and interpolation controlled and shaped by a VJ using automated processes and a MIDI controller.

Ex Machina Section 1 Markov Chains

The Max/MSP patches employed for generating MIDI in Sections 1, 4, and 6 either specify the transition states (1, 6) or use the Markov Object to generate states based on training data from a MIDI file. In Section 1, transitions are determined by pre-set messages, and the Markov object triggers sonorities contained within the coll object

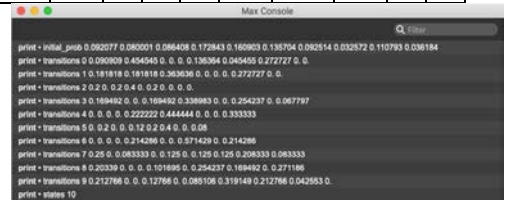
“OpeningChords.” Transition states are shown in message boxes (0-9) (center of window). Note that messages specifying transition states need not sum to 1.0 (Ex. 2). The Markov object scales transition states regardless of input values (Ex. 3), enabling the user to weight values intuitively. The duration of sonorities is generated by a second Markov object with three states (Ex 2-RhythmsSlow). Each of the three durations are Phi proportions $X(1.618)$. [1] Markov objects in Section 1 use first-order chains (memoryless). [2] Comparison of weighted random, 0th, 1st, 2nd and 3rd order chains will be discussed in reference to Section 4 of the work.



Example 2: Ex Machina Max/MSP Section 1 patch.

The Max Console window below shows interpolated transition probabilities. Compare Ex. 2 and Ex. 3 transition “0” (pictured).

.2	1	0	0	0	.3	0.1	.6	0	0
.09	.45	0	0	0	.14	0.05	.27	0	0



Example 3: Ex Machina Max/MSP Section 1 transition states interpolated.

4, 8], and as pitches are triggered in the Max/MSP patch, these structures emerge as musical phrases more or less depending on the order of the Markov chain.



Example 6: Ex Machina Section 3 instrumental solo, mm. 111-14.

The table below shows the PC's and the number and percent occurrences of each in mm. 111-14 of the solo. Transitions are calculated from these (Ex. 8).

PC.	# of occurrences	% occurrence
G	5	17%
F#	2	7%
B	10	33%
C	2	7%
E	4	13%
D#	7	23%

Example 7: Ex Machina Section 4 mm. 1-4 pc's and weights.

The transition matrix below is calculated from pitch motions in mm. 111-14, and the weights above.

	G	F#	B	C	E	D#
G	0	2/5	0	0	0	3/5
F#	0	0	1	0	0	0
B	3/10	0	0	2/10	2/10	3/10
C	0	0	0	0	1	0
E	1/4	0	1/2	0	0	1/4
D#	0	0	1	0	0	0

Example 8: Ex Machina Section 4 1st order Transition Matrix.

This is the same 1st order matrix showing probabilities as decimals.

	G	F#	B	C	E	D#
G	0	.4	0	0	0	.6
F#	0	0	1	0	0	0
B	.3	0	0	.2	.2	.3
C	0	0	0	0	1	0
E	.25	0	.5	0	0	.25
D#	0	0	1	0	0	0

Example 9: Ex Machina Section 4 1st order Transition Matrix.

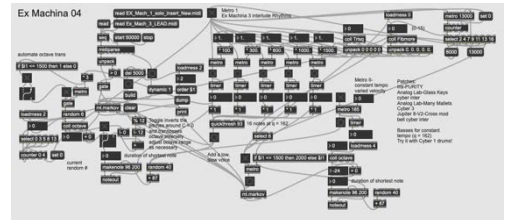
The transition matrix for this particular sample is convergent as shown below. Note that the values resemble the original weighted distribution shown in Ex. 7. The example is of the 100th order matrix.

	G	F#	B	C	E	D#
G	.14	.06	.36	.07	.14	.23
F#	.14	.06	.36	.07	.14	.23
B	.14	.06	.36	.07	.14	.23
C	.14	.06	.36	.07	.14	.23
E	.14	.06	.36	.07	.14	.23
D#	.14	.06	.36	.07	.14	.23

Example 10: Ex Machina Section 4 Convergent matrix 100th order.

Ex Machina Section 4 Markov Chain Examples

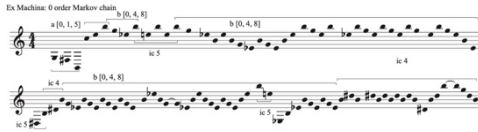
The following musical examples were generated during a session with the Section 4 patch. Transitions for each Markov Chain are calculated by the Markov object after processing MIDI file input. Rhythms are generated by the RH side of the patch. Generated rhythms maintain a constant flow of pitches with a gradual rallentando over the course the Section 4 (ca: 4:30).



Example 11: Ex Machina Section 4 Max/MSP patch.

The 0th order Markov chain behaves as a weighted random sample of PC's from phrase A. Pc's B, D#, G, and E mirroring percent weights in the original (Ex. 7), and both *b* [0, 4, 8], and *ic* 4 occur frequently. A [0, 1, 5] appears only at the beginning of the example, with [F#, G, B; C, E, B] occurring once each. *lc* 5 [B, E], a subset of *a*, occurs in the first system

and as [F#, B; B, E] in the second. In these instances, neither G nor C are present to complete a [0, 1, 5]; the pattern in phrase A. Melodic contours in this example do not closely resemble the original.



Example 12: Ex Machina Section 4 0th order Markov chain.

Example 13 shows the result of using a 1st order Markov chain. *ic 4* and *b [0, 4, 8]* still dominate the texture, but statements of *a [0, 1, 5]* happen more frequently; at the beginning of the first and second systems and at the end of the example roughly in the same order as phrase A. Melodic contours in this example are beginning to resemble the original phrase.



Example 13: Ex Machina Section 4 1st order Markov chain.

The 2nd order Markov Chain mirrors the original more closely than the others. Compare Ex. 14 with Ex. 6 and *a [0, 1, 5]*, *ic 4*, and *b [0, 4, 8]* all appear in their original order, and contour with few exceptions. As the 2nd order chain is triggered over the course of Section 4, it maintains a close relationship with the original with distributions of *a [0, 1, 5]* occupying about 40% of the output while, *b [0, 4, 8]*, and *ic 4* occupy approximately 60%. These percentages approximate their distribution in the original solo.



Example 14: Ex Machina Section 4 2nd order Markov chain.

Based on the congruence of the 2nd order chain, one might assume that the 3rd order chain would resemble the original even more closely, but this is not the case. In example 15, which uses a 3rd-order Markov chain, more PCs are repeated, and the clear contours of the 2nd-order sequence are fragmented and unrecognizable when compared to the original phrase. 3rd and higher-order Markov chains will approach the probabilities of the matrix from Ex. 10, which mirrors the weighted distribution of the 0th-order chain over time. In Ex Machina Section 4, the 2nd-order chain was used because it generates pitch content closely resembling the original solo from Section 3.



Example 15: Ex Machina Section 4 3rd order Markov chain.

Conclusions

In much of my earlier electronic music employing algorithmic processes in Max/MSP I have used varying degrees of randomness shaped by range limits, pc content, rhythmic limits, random walks, etc. In *Ex Machina*, I created a musical context in which musical events triggered by Max/MSP patches more closely mirrored the music of composed sections. The previous examples demonstrate that Markov object in Max/MSP is one way to achieve musical

unity by defining content, probabilities, and the order of the Markov chain.

Notes

1. For Section 1 Rhythmic durations are: 6000 ms, 9708, ms, 15707 ms; Section 6: 5000 ms, 8090 ms, 1390 ms.
2. Nomenclature: A-phrase, At-transposed, At'-transposed and varied.

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Kaleidoscopes - Kaleidospaces on a building scale and their inner orchestrated spatial choreography

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Introduction

Space is not a passive vacuum but is controlled by forces that express organization and order and compels all the bodies and forms which inhabit it to adhere to extremely powerful constraints.

The understanding of that order is vital to the functioning of the architect and of any person connected with or responsible for the design of human habitat space.

Space possesses a structure (a system among whose components exist well-defined relationships) of hierarchic and periodic (geometric and topologic-mathematical) character that can be represented by mathematical models and its symmetries.

Every periodic complex form can, through a continuous process of reduction and symmetric subdivision, be broken down to its basic atomic spatial elements and, conversely, by activating the appropriate mechanism of reproduction, deriving from the

symmetry of its basic cell, reconstruct the entire complex periodic configuration.

According to this conception, the essence of the periodic complex dwells in each of its basic particles. These particles (in crystallography science called: the 'fundamental domains') should contain a full representation of all the traits of the complex and the key to both its dismantling and its reconstruction.

The representing features of this relations between the simplex and the periodic complex are the symmetry elements and their group-agglomerations.

Kaleidoscopes

The subject of kaleidoscopes is associated in many minds with childhood toys, constructed of mirrors, in a configuration which generates a periodic replication, through the action of

reflection symmetry operations only, resulting mostly in kinematics 2-D ordered mosaics. The toy is with us about 200 years.

The original “Kaleidoscope” invented by Sir David Brewster, in about 1816 and the meaning of Kaleidoscope is ‘seeing a beautiful form’ (Greek), the essence of which is:

Two parallel mirror reflectors generate an infinite group of virtual mirrors which appear to act like real mirrors.

The issue of ‘symmetries’ invades and dominates many field theories, concerning art, mathematics and widely researched physics and chemistry domains.

“When we say that a figure is **symmetrical**, we mean that there is a **congruent transformation** which leaves it unchanged as a whole, merely permuting its component elements... such a congruent transformation is called a **Symmetry operation**” (Coxeter).

Clearly all the symmetry operations of a figure together form a group ... that is called the **symmetry group** of the figure.

Groups of (real or virtual) mirrors generate sometimes translation symmetries ...

.... Discrete groups generated by reflections, including as special cases the symmetry groups of the regular polyhedra and of the

regular and quasi-regular honeycombs, have emerged in the last 300 years or so.

The trihedral kaleidoscope which exhibits the transforms of a point under a group generated by reflections, is due to Möbius (1852). Fig. 1, Fig. 2.

Observed conceptually, the kaleidoscope is a derivative of a consuming optic-geometric-mathematical phenomenon.

The kaleidoscopes are solved to replicate a specifically designed motif-form in a finite-spherical or two or three vectorial expansions to infinity, of either toroidal or hyperbolic patterns.

Usually, these space units comply with the definition of Elementary Periodic (fundamental) Region (E.P.R). The number of

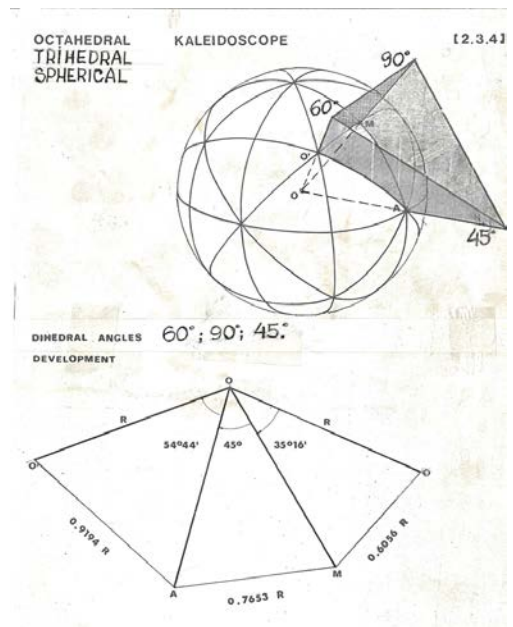


Fig.1 *Octahedral Trihedral Spherical Kaleidoscope*

such kaleidoscopes is mathematically exhaustible. Less familiar are the 'complex kaleidoscopes', consisting of an arbitrary number of E.P.R units. Their number is, of course, infinite and their exhaustive enumeration is a matter of complex mathematical combinatorics.

- The kaleidoscopes represent a critically important aspect and chapter in the science and morphology of space: of symmetry groups in the 2D and 3D space with a direct generic relation to crystallography and morphology of the matter world; the plain and the hidden world of crystals, on its atomic and molecular level. We may represent the translational 3D symmetry group by a space lattice or a "Bravais Net". It is obvious that we can define the physical arrangement of the whole crystal structure if we specify the contents of its single **unit cell**. (Ziman)

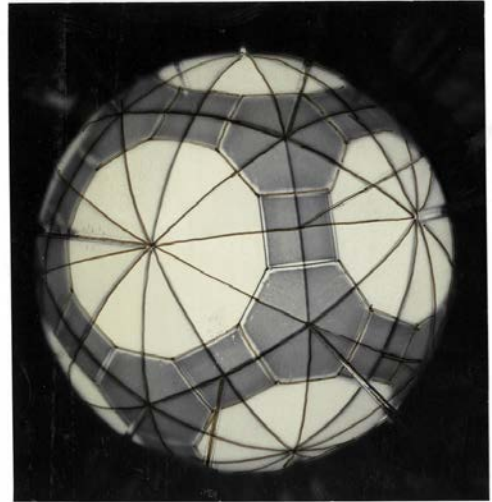


Fig.2. *Icosa-Dodecahedral Trihedral Spherical Kaleidoscopic image, with one vertex located within the E.P.R. unit.*

It should play an important role in the built and the urban architectural environment, as well, immersed, as it is, in glass and mirror cladding and partition solutions, resulting from the prevalent technology and the design spirit of our times.

The kaleidoscopes and the whole issue of periodic replication are not established as a coveted knowledge domain, which could promote objectives of architectural design, although some inkling of the 'potential' already penetrates and becomes visible through the architectural environment. Designers and architects are still mostly unaware and ignorant of the potential of this topic to inspire creative treatment of the urban habitat and its environment.

Kaleidospaces

The magic of the Kaleidoscope is in representing that evasive boundary between the real and the virtual world. It is a domain of many paradoxes and visual deceptions; a challenging world imbued with mystery, illusion and profound questions regarding the nature and the structure of the space we live in.

Probably, the first realization of a kaleidoscope on a building scale was the **Canadian pavilion** in the Expo-67 in Montreal. Fig. 3. The essential impact on a visitor was achieved through an orchestrated (predesigned) of 12 minutes only of exploding colours.



Fig. 3 *The Canadian Kaleidoscope Pavilion at Expo- 67, in Montreal, Quebec.*

The ‘wonderment walk’

The ‘kaleidospace’ may be resolved within one single building-scale kaleidoscopic structure or developed as a ‘wonderment walk’ through a successive composition of pre-determined kaleidoscopic spatial features.

The kaleidospaces will be an all-encompassing sensual experience and an ultimate illusory entertainment vehicle.

One kaleidospace structure or a conglomerate of different types of kaleidospaces, connected by short passageways, could serve as a

multi-media adventure space, a real 'wonderment walk'.

The 'wonderment walk' should be disassociated, as much as possible, from the everyday experience of the urban space, as we know it, striving to suffuse the real with the virtual, illusory sensation. The 'wonderment walk' should assault the ingrained visual 3D perception and spatial orientation to a point of reaching a departure from the real, the familiar and the solidity of our space conception.

That is the essence of Escher's bewildering space ambiguities and that should be mobilized as a starting point of the wonderment walk.

To some extent it is an invitation to immerse ourselves in the 'Magic' Mirror environment of M.C. Escher (1898÷1972) and experience his 'pseudoscopic effect'. Fig. 4.

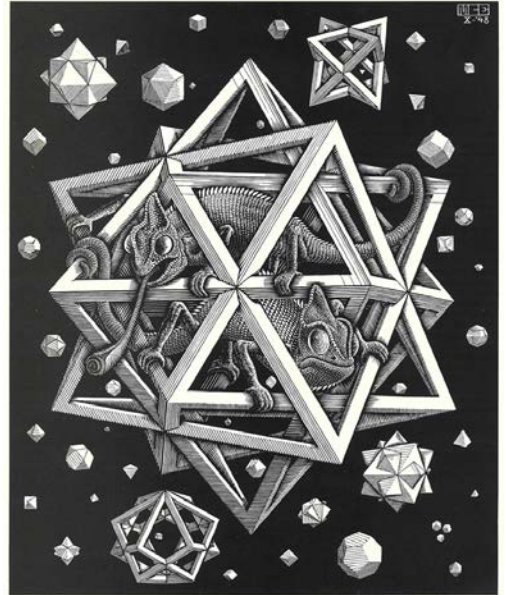


Fig. 4 Wood engraving by M.C. Escher, 1948.

“Escher also created spheres whose curved surfaces are filled with a single repeating motif-form. It is likely that in covering these spheres with adaptations of his flat designs he first envisioned the pattern wrapped around a suitable solid such as a cube or octahedron, then projected the designs outward to the surface of a sphere surrounding the geometric solid” (M.C. Escher Kaleidocycles). Fig. 5.

Kaleidospaces are **kaleidoscopes realized on a building scale**, solved to accommodate groups of active visitors-participants-spectators as the

replicated motif-form, thus turning their (even) random interactive movements into an orchestrated, ordered, all-embracing (virtual) environment. Within the Kaleidospaces an exciting transformation takes place, replacing the

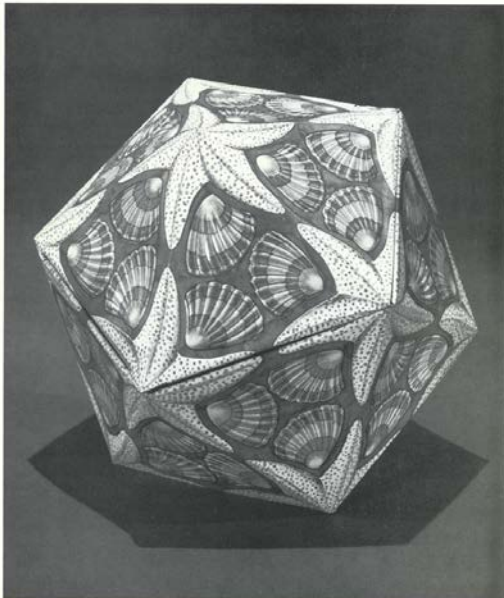


Fig. 5. *Enamelled tin icosahedron* by M.C. Escher, 1963

intellectual perception with an intense artistic-sensual experience. The ir phenomenology and conceptuality and the associative means of creative and expressive design perceptions are not yet understood and developed, which poses a c rippling effect on an y

effort to communicate and discuss the issue. Fig. 6. Fig. 7.

A special attention should be given to what I suggest calling- 'kaleido-choreography'-in which all the participants and their random or orchestrated movement generates periodic kinematics choreography, characterized by an exciting fusion of the arbitrary and the totally ordered and highly symmetrical movement regime.

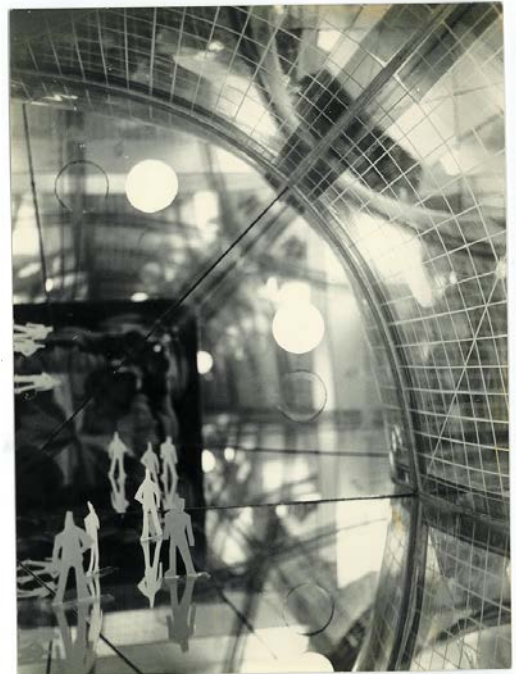


Fig. 6 *A kinematic Cubic Kaleidospaces, (Kaleidocube).*

Essentially the Kaleidospaces are mirror-clad interiors of very particular geometries and are within the practiced building technology and industry, with

economics of glass-mirror facades construction. The size is of a particular importance, to insure the sensual knock out, and ... **the bigger the better.**

It should be stated that the kaleidospace conception, as described, goes much beyond the 'Canadian Pavilion' concept, as realized and presented in the Expo-67 in Montreal.

Its principal contribution novelty is in turning the visiting crowd into its main, most effective replication motif-form.

Icosahedral Kaleidospace: an elementary region of space which represents 1/120 of the total illusory spherical space. Fig. 8. Fig. 9. With a right triangular basis of 18m x 27m, it will rise to the height of ~50m and will recreate an illusion of a spherical space of 100m in diameter.

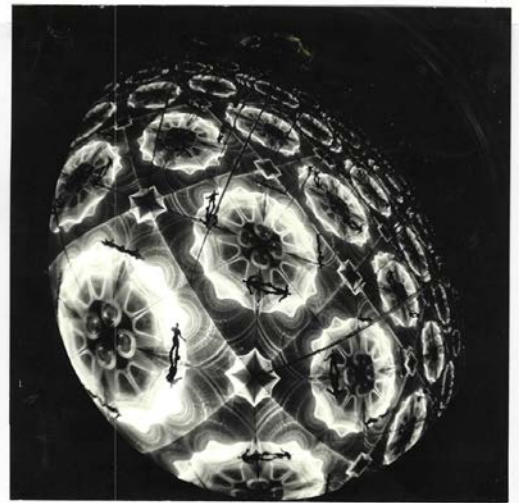
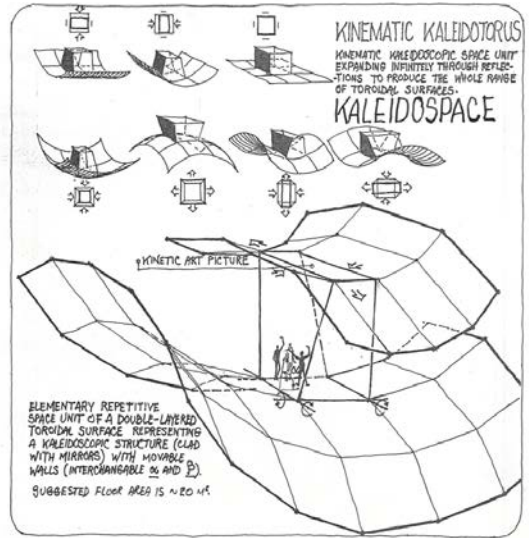


Fig. 7 A Kinematic Toroidal Kaleidospaces (the Kaleidotorus).

Whatever is inside will be reflected and replicated 120 times. Visitors (300 at a time) will generate a "human kinetic carpet," covering the entire inner surface of the sphere.

The kaleidospace array of interiors may be engulfed in a multi-layer spatial environment, suffused with vertical-spatial park of green biomass and a spatial grid of pedestrian (and mechanized) walk-ways and 'sky promenades', with a servicing visual-functional supportive environment.

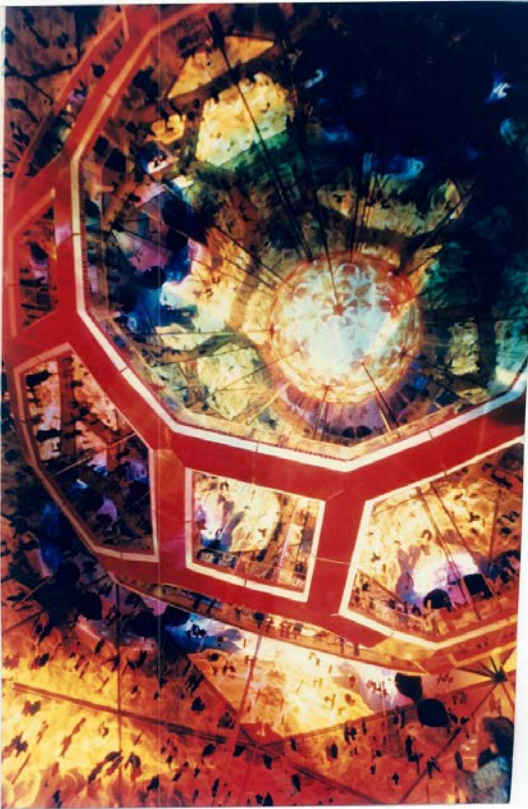


Fig. 8 *Spherical Kaleidospace, referring to 2.3.5. (Icosahedral) symmetry group, with a pedestrian bridge as its replicated motif form.*

As such, and especially when utilizing the 2.3.5.(Icosahedral symmetry) trihedral mirror clad space, it was never realized and never experienced before, and therefore will constitute a complete novelty and 'a first' of its kind. Fig. 10.

Its starting point was in 1972 with the author's small-scale experiments, encouraged by an esteemed colleague Prof. Paul Conrad Hoenich (1907-1997), 2D design instructor at the Technion's Architecture Faculty, who was a generator and worshipper of Sun-Art design and sun painting and a very distinguished photographer, with some of his photographs presented here.

Some of the early design and research efforts of the author on the Kaleidospaces phenomenology were presented in an 'art exhibition' at the Haifa Art Museum (Israel) in 1984.

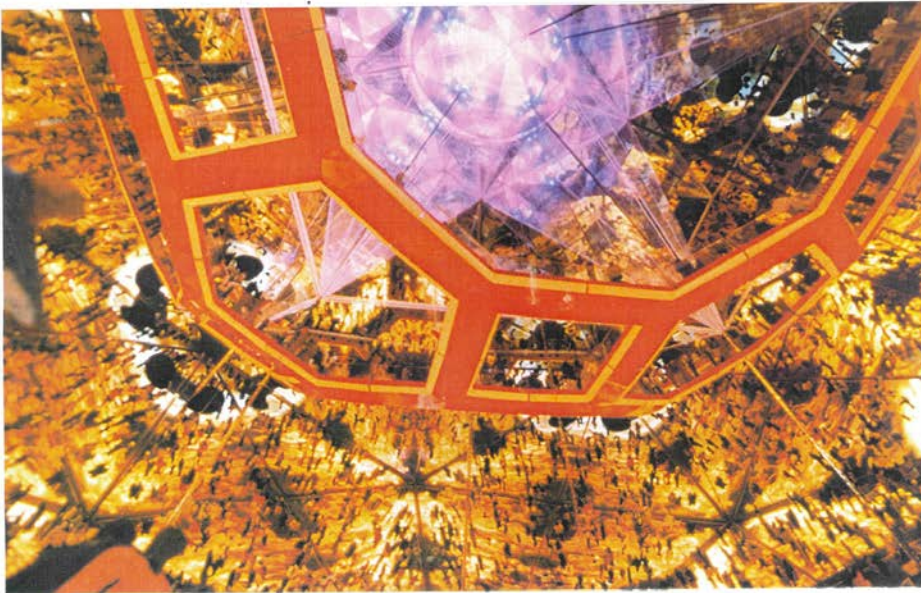
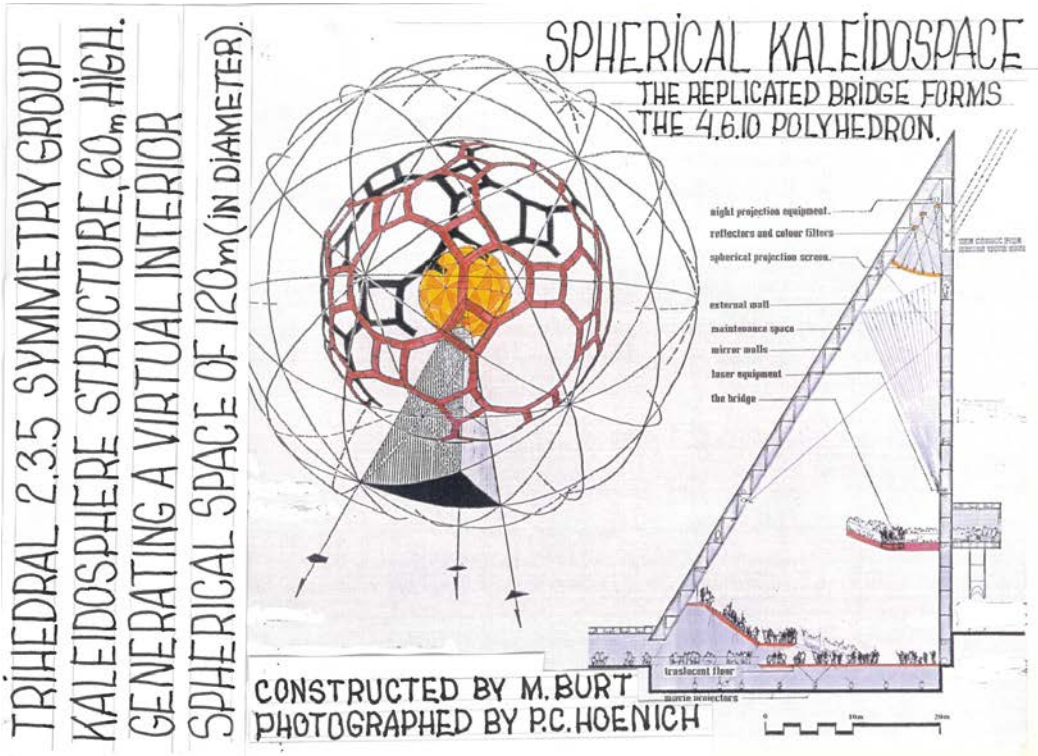


Fig. 9. A Spherical Kaleidospaces, referring 2.3.5. Icosahedron) symmetry group.



Fig. 10 *Kaleidospace of 2.3.5. symmetry group.*
Photograph by P.C. Hoenich, with his sun-paintings as a replicated motif-form at the truncated top of the Kaleidospaces.

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To See the Invisible. Inphrastic Inspirations by Night Nature Photography. From Photography to Audiovisual Composition

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Abstract

The composition To See the Invisible for the six performers by Katarzyna Kwiecień-Długosz selected for discussion is an *artistic inphrasis* showing an artistic representation of the content and emotions previously existing in the philosophy and photography of Georg Shiras, and later in the painting of Aneta Kublik. The resulting artistic artefact is an emotional reference to the work of art from which the painter, and then the composer, drew inspiration. The modification of one code to another occurs in a symbolic space, which is related to the phenomenon of the mutual permeation of arts and the expression of a non-verbal work. The subject of Aneta

Kublik's paintings is the feeling of anxiety and suffering caused by frightened roe deer. The original painting technique used, based on the clash between light and black oil paint applied in a sculptural manner, caused the symbolic meaning to cross its original boundaries: the calm of the deer in the forest. The aesthetic experience at hand is about lyrical abstraction hidden in philosophy and inspiration drawn from another work of art. Inside the painter, at the moment of this experience, the vision develops of the artistic work.

The emotions contained in these paintings by Kublik were later reflected in the audio-visual composition by Katarzyna Kwiecień-Długosz. During the playback of the music material, the paintings are displayed that complete the narrative, creating an intermedial composition. The musical work contains various intermedial references; it uses and is inspired by three sources: photographic, painterly and philosophical. Yet the symbolic structure of the composition refers to the painting, and the music material suggests to the audience a transition from darkness to lightness with changing moods and colours.

Key words: intermediality, inphrasis, contemporary music, images, art, audiovisual art

1. Introduction. Scope of study

This article presents an analysis of an audio-visual work by the contemporary Polish composer Katarzyna Kwiecień-Długosz.

The work is an example of an *artistic inphrasis*, whose aim is to arouse emotions evoked by the paintings of the young Polish painter Aneta Kublik and to recreate these emotions in an audio-visual work.

Audio-visual art is based on combining sound with visual elements into a single structure, ensuring a continuous fusion of these media, creating a single integrated artistic message.

Generally, sound, video projection, lighting, digital and interactive technologies are used to create an audio-visual work. Therefore, this type of intermedial work requires an interdisciplinary approach.

The main aim of audio-visual art is to convey the emotions contained in the sound and visual layer. Among the best-known forms of audio-visual art are sound installation, audio-visual installation and audio-visual performance.

As it is known, there is still no uniform, established scholarly discourse and description methodology that will cover all genres of visual arts, music, theatre and cinema. As the scholars of this issue rightly observe, 'despite the growing interest of modern cultural studies and art critics in this, the issue of audio-visual discourse in modern digital culture remains insufficiently covered. A theoretical basis is being formed, and the active development of digital media involves the constant updating of factual materials' [3].

Thus it seems essential not only to study the influence of new technologies on the creative process, but also the intermedial relationships being formed between individual media.

The composition selected for analysis, *To See the Invisible* for six performers (2019) by Katarzyna Kwiecień-Długosz, reflects the inphrastic reconfiguration of specific works of art: paintings by Aneta Kublik (a contemporary Polish painter; <https://www.anetakublik.pl>). The use of selected paintings by this painter as source material for creating an audio-visual work played an important role in achieving the expression and dramaturgy of the work. It was the emotions resulting from and the painter's concern and anxiety, reflected in the cycle of works entitled '*Zobaczyć niewidoczne*'/'*To See the Invisible*', that provided the basis for *artistic inphrasis*.

The concept of *inphrasis* is described today by Kamila Woźniak in her studies on photographs as a carrier of literary content. She claims that 'there is a peculiar double interpretation [in this play] – the viewer interprets the artistic interpretation of a literary work. He attempts to reconstruct the artist's line of thought, at the same time recreating in his memory the content of the literary work to which the photograph refers [...] This confrontation with an artistic work will be complete only when the viewer discovers and recognizes the literary cultural code, and the artist reveals this code (in the form of the title of the photograph or a very clearly defined symbolism that appears in it) will expose to him' [5].

In contrast, my definition of *inphrasis* comes from a radical redefinition of the

concept of *ekphrasis* proposed by Siglind Bruhn. The scholar, proposing a new concept of 'musical ekphrasis', described the phenomenon as a 'representation in one medium of a real or fictitious text composed in another medium' [1]. As Laura Sager Eidt aptly described, '[...] ekphrasis need not be purely verbal. If the goal of verbal ekphrasis is to make the reader see, cinematic ekphrasis can also be discussed in terms of its effect on the audience' [2].

This argumentation allowed me to produce another redefinition of the term *ekphrasis*, which would be appropriate to define the intermedial relationships present in an audio-visual work. The term *inphrasis* has only been introduced recently and is gradually being extracted from visual arts. Exploring the relationship between individual verbal and non-verbal media, I formulated my own definitions of *ekphrasis* and *artistic inphrasis*,¹ which I used to interpret selected contemporary intermedial works on an emotional and symbolic level.²

2. To See the Invisible – night nature photography as inphrastic inspiration

The point of departure for the analysis of the selected audio-visual work is a night nature photograph (frightened roe deer) and philosophy, which originally inspired the painter.

In the piece selected for discussion, we deal with a juxtaposition of four different media: painting, photography, philosophical thought and music, which condition visual and auditory experience.

It is this expressive transition from darkness to lightness with altering moods and colours that becomes a symbol of a visual, and then audio-visual, work.

2.1 The painting (source medium). Inspirations and message

The painting *To See the Invisible* by Aneta Kublik is the result of her inspiration and fascination with the photography of Georg Shiras, one of the pioneers of night nature photography. „As a result of his ingenuity, Shiras succeeded in capturing the first nighttime wildlife photographs ever created. They were the first wildlife images to use both flash photography and camera trap equipment” [6]. The painter also drew inspiration from Frida Kahlo's *Wounded Deer*, Franz Marc's *The Fate of Animals* and Gerhard Richter's *Deer*.

Aneta Kublik based her cycle of paintings on the philosophy of Arthur Schopenhauer and Emil Cioran, thus trying to express and elevate the emotions that we usually want to hide. The author of the paintings attempts to prove in her oeuvre that strong sensations need an outlet and may transform into a work of art inspired by extreme emotions. The title of the cycle *Zobaczyć niewidoczne* seems to best emphasize the above.

The aesthetic experience resulting from the reception of the photographic work and reading the sense of philosophical thoughts provoked the painter to express this content in a visual way. Painting, like any other type of art, should be based on the artist's experiences, feelings and sensations in order to become more

meaningful. Emotions resulting from deciphering the hidden meanings of a work may also be transferred to another work of art or a literary work, creating the phenomenon of *artistic inphrasis*. Aneta Kublik's *inphrases* are not typical pictures-illustrations of fleeing animals. Thanks to the painting technique used and the external play on light, they express emotions aroused by reading philosophical thoughts and looking at photographs; they are an experience in themselves.

The young Polish painter was fascinated by the feelings of animals that became restless at night under the influence of unexpected camera flashes, which she recorded in traditional painting in 2011. As time passed, Aneta Kublik dropped the classical chiaroscuro, perspective and colours, the collision of a beam of light with the blackness of oil paint becoming the sole element.

Kublik's cycle of paintings entitled *To See the Invisible* is an expression of the feeling of hidden emotions which the painter captured in thick paint painting, thanks to which the imaginary moods take on specific real form. The theme of the series is the inner mood of experienced fear, anxiety and uncertainty, which is difficult to express in a painting. The epitome of these emotions are the skittish roe deer that hide in the forest landscapes. Thus the deer became a figure, a symbol of the artist's dark experiences. Black in this painting becomes a colour that reflects these moods.

In order to precisely express her emotions, the painter uses a limited colour palette that only comes to life under light reflections. As a result, the gesture, which is a painting trace and, simultaneously, a symbolically loaded

creative act, plays the fundamental role. The use of an innovative painting technique based on the use of a thick layer of paint on the canvas creates the impression of a sculpture that is a challenge for both the painter and the recipient of this art. This light becomes the main creator of artistic emotion and narrative in this work. Depending on the angle and incidence intensity, a new work is created in which one may notice motion and hidden colours creating different representations each time (see Figure 1, 2, 3).



Figure 1. *To see the invisible*, 2019, oil on canvas 1x2m. Reproduced by consent of Aneta Kublik

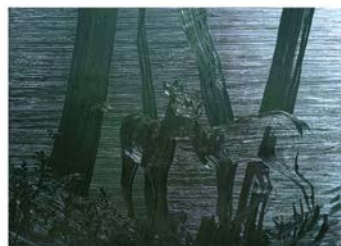


Figure 2. *To see the invisible*, 2019, oil on canvas 100x160cm. Reproduced by consent of Aneta Kublik



to see the invisible, 2019, oil on canvas, 0,9x1,2m

Figure 3. To see the invisible, 2019, oil on canvas 0,9x1,2m. Reproduced by consent of Aneta Kublik

2.2 Audio-visual work

The audio-visual work *To See the Invisible* for six performers was written to the cycle of paintings *To See the Invisible*. The piece was inspired by Aneta Kublik's exhibition, which the composer saw at the Academy of Fine Arts, Art Armoury in Gdańsk in 2018. The composer was particularly inspired by the limited colour palette and the figurativeness of painting.

The collaboration consisted in making a film (the visual layer) that used three paintings being presented in changing light (see Figure 1, 2, 3). This film, in turn, became the basis for composing the sound layer that musically commented on the emotions and symbols hidden in the paintings. In the music, similarly to the visual layer, there is a transition from darkness to lightness with changing moods and colours. The film containing selected paintings is thematically synchronized with the musical layer of the composition.

The source medium was transferred to a new medium; the visual layer displayed live during the sound playback. Sensory perceptions of image and sound are not

only a synthesis of the impressions being received, because they are enriched by their reproduction in the audience's memory. This means that everyone may interpret a work of art differently and perceive emotions differently.

In her compositions Kwiecień-Długosz uses the sounds of traditional instruments (flauto grande, clarinetto basso in si bemole, violino, viola, violoncello, contrabbasso a 4 corde).

The instruments' tone colour, changes in dynamics and rhythm used, as well as the original articulation and melodic line shapes become a reflection of the emotions triggered by fear and unpredictability, although in fact the emotions still refer to their painterly depiction.

Two wind instruments (flauto grande, clarinetto basso in si bemole) musically illustrate two young roe deer. The strings, on the other hand, help to reflect the emotions accompanying the situation in which the animals found themselves. The use of harmonic glissandos, flutter-tonguing, non-rhythmicized tremolo, against which the thematic lines built on irregular rhythmic values resound, intensifies the dark and disturbing moods in the listener. The skittishness of the roe deer is reflected in the sudden interruptions in the musical narrative (see Figure 1, 3).



Figure 4. K. Kwiecień-Długosz, *To See the Invisible* (score). Reproduced by consent of the composer

By contrast, the slow pace, long-reverberating sets of pitches in the strings, against which the cantilena melodic lines performed by the flute and the bass clarinet are presented, and, importantly, greater bursts of light, all calm down the dramatic scenes. The dialogue of these instruments symbolizes the blissful mood of two small roe deer that found a safe refuge behind the trees (see Figure 2, 5).



Figure 5. K. Kwiecień-Długosz, *To See the Invisible* – score. Reproduced by consent of the composer

The composer divided the large-scale form of the work into seven sections accompanied by various scenes of the

film being played. Sections marked with capital letters of the alphabet are a separate event from the life of roe deer:

Scenes of lurking danger; crouching deer anxiously waiting in the dark forest to escape

Introduction (bb. 1-16)

A (bb. 17-24)

Scenes of deer's escape

B (bb. 25-31)

C (bb. 32-44)

D (bb. 45-70)

E (bb. 71-91)

The scene of finding a safe refuge

F (bb. 92-120)

In the presented work, we are dealing with a specific coding, when a musical work uses and is inspired by two sources: visual (painting, photography) and philosophical, yet the symbolic structure of an audio-visual work always refers first to the original, that is, photography and philosophy.

Therefore, a musical work should be played together with the visual layer (a film with selected paintings and light emission) in order to properly convey the emotions hidden in individual media. The audience may follow the narrative being constructed by the intermedia message live.

3. Conclusion

Taking into account the issues relating to defining intermedial phenomena, as well as the variety of terms, reveals how complex the matter that we are dealing with is when analysing the relationships developing among the areas of creativity.

The composition by Kwiecień-Długosz is an artistic artefact that is an emotional reference to the work of fine art from which she drew her main inspiration (painting, visual layer). The modification of one code to another occurs in a symbolic space, which is related to the phenomenon of the mutual permeation of arts and the expression of a non-verbal work. The painter's aesthetic experience, in turn, concerns lyrical abstraction hidden in philosophy and inspiration by another work of art. Inside the painter, at the moment of this experience, the vision develops of the artistic work. Present here is the phenomenon of a mutual permeation of meta-artistic texts, which is a reflection of a non-verbal (photographic, film, visual) or verbal (philosophical content) medium in a non-verbal medium (audio-visual work), typical of *artistic inphrasis*. *Inphrases* are the emotions of frightened roe deer recorded first in the photograph and then in the painting, later transferred to the audio-visual layer.

Kwiecień-Długosz, in the musical layer of her audio-visual composition *To See the Invisible*, attempted to fully convey the feelings and symbolism that may be read in Kublik's paintings. 'The peculiarity of the symbolism of [Aneta Kublik's] paintings seems to be an attempt made in them to express the suffering inherent in human existence, set, as it were, in the metaphysical blackness preceding birth, which, after all, no light of life may illuminate [...]' [4].

Therefore, the audience's attention is focused not on the painting or the music itself, but on the illuminated elements of the paintings with expressive music, which come to life, gaining a symbolic dimension, creating inphrastic inspirations. It is them that evoke in the audience emotions transferred from the original medium updated with a new aesthetic experience.

Notes

1. Artistic ekphrasis – a verbal interpretation of music or other artistic medium; the use of a verbal medium for representing a non-verbal medium. It consists of an artistic description of works of art or a reference in a literary work. The author of such text describes not only the original work of art that made an aesthetic impression on him or her, but also introduces the author's subjective element into the description, thanks to which the work of art gains a new dimension; it is enriched with a new context and interpretation. The overriding goal of ekphrasis is to evoke emotions resulting from the contemplation of a work of art, as a result of which a description of the work of art or a different kind of reference to the perceived object of artistic creation appears in the narrative layer.

Artistic inphrasis – respectively: musical, choreographic, visual, plastic, is a process opposite to ekphrasis; it is an intermedial work or its excerpts that convey emotions using appropriate means resulting from the interpretation of literary content or other work of art (original work). Artistic inphrasis is a phenomenon of mutual permeation meta-artistic texts, which is a reflection of a non-verbal (musical, choreographic,

cinematic, visual) medium or a verbal one in a non-verbal medium.

2. The research results were presented at the 16th International Scientific Conference *Music Science Today: the permanent and the changeable*, Daugavpils University Vytautas Magnus University, 2022; subject of presentation: *Artistic Ekphrasis and Inphrasis. A Term in the Studies of Intermedial Works*. The results will have been published in the scholarly journal *Nova Contemporary Music Journal* 2022, Vol. 3, Musical Performance as Creation International Conference Proceedings, Centro de Estudos de Sociologia e Estética Musical Lisbon, Portugal.

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Good-for-nothing (working-class Italian gentleman #1) and Good-for-nothing (working-class Italian gentleman #2)

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Abstract

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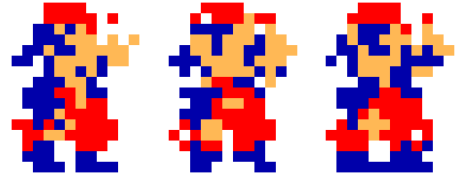
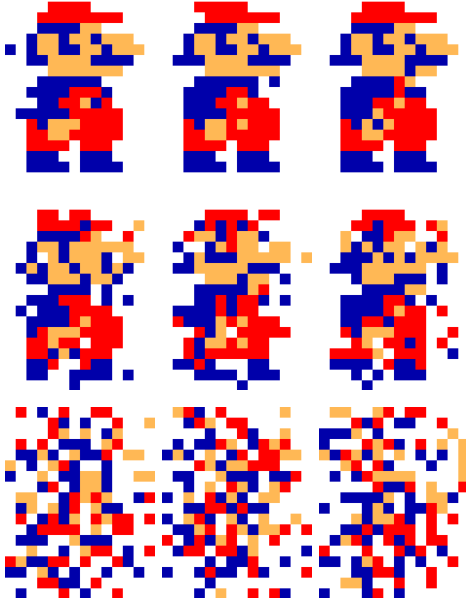
What is a portrait (What is it a portrait of)? Must it achieve verisimilitude (is it possible to achieve likeness of an entity that does not exist)? What constitutes existence (do memories exist)? These questions, and more, are all asked, and never answered, by Good-for-nothing (working-class Italian gentleman #1) and

Good-for-nothing (working-class Italian gentleman #2).

This diptych of good-for-nothings address Mario—one of the most recognizable 'portraits' of the digital era. Immediately identified by so many, Mario has had impact across multiple generations,—from those who first encountered him as the Jumping Man in Donkey Kong, to his outsized presence in a familial universe of pipes and mushroom, to finally a much more open universe where Mario and his ilk inhabit the roadways, sports arenas, outer space, etc. Are these in fact the same Mario—the plumber and the motorist? Is the continuity of a representation even able to imply continuity of that which is represented?

Good-for-nothing (working-class Italian gentleman #1) takes as its input a canonical sprite from Mario's initial appearance in Donkey Kong. A pixel is selected at random and its position (or color, depending on how you look at the world) is swapped with a randomly selected adjacent pixel. At what point is

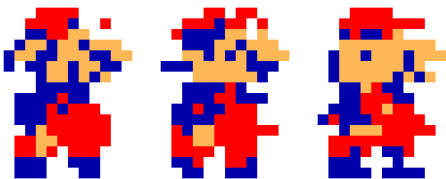
Mario's identity compromised to the point that portraiture becomes caricature?



From this simple numerical model of Mario-ness, a vast array Mario-like entities can be drawn—in fact were one to draw them all, a canonical Mario would necessarily appear. But which, if any, of these representation can be said to be depictions of Mario. Where does the Mario-ness lie?

When does semiosis shift from an iconic representation of Mario to a symbolic representation of an ersatz working-class Italian gentleman? Eventually ambiguity further deteriorates this symbolism, and finally the indexicality of abstraction takes hold.

Good-for-nothing (working-class Italian gentleman #2) revisits ideas we explored in Good-for-nothing (no. 2). The probability of a color appearing in each row and column of the same sprite is calculated; as well as the probability of any color appearing adjacent to other colors.



Practices of programming amateur computer graphics in the 8-bit microcomputer era

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The emergence of the 8-bit home computers in the early 1980s had a substantial impact on amateur creative practices with available graphic and sound capabilities of such hardware. With my paper, I explore a range of creative practices related to visual culture artifacts, both static graphics, and animations made with such computers. While doing so, I am particularly focusing on the availability of knowledge necessary for an engagement in such practices and its impact on shaping aesthetic conventions.

Microcomputers of the era such as the Apple II, Commodore 64, ZX Spectrum, CPC Amstrad, and BBC Micro offered easily programmable graphic chips. Moreover, such computers were accompanied by easily available hardware reference manuals and

tutorials (Fig. 1) that provided detailed descriptions of what such chips can do and how they can be efficiently programmed. The availability of such easy-to-understand hardware and knowledge formed an ecosystem for the creation of generative art through program code.

With my paper, I investigate what kind of digital tools and relevant knowledge on using them were available for those interested in experimenting with computer graphics outside of professional computer graphics art worlds. I argue that the available knowledge that came from available hardware manuals, books on computer graphics, and computer magazine sections on programming graphics had both technical and aesthetic aspects.

This is an academic paper that will be supported by a multimedia presentation that demonstrates some examples of the aesthetic of programmable graphics made by amateurs. This paper communicates selected research findings from my ongoing research project on amateur programming culture and creativity in the 8-bit microcomputer era. As source material for my paper, I use hardware reference manuals, programming books dedicated to computer graphics and animations, tutorials in computer magazines, and preserved programs that include relevant graphics and animation.

supported by a 4-year research grant from the National Science Centre of Poland. He has published articles in *IEEE Annals of the History of Computing*, *International Journal of Communication*, and *History and Technology*.

He holds MA titles in sociology and art history (Warsaw University) and a Ph.D. in cultural studies (Warsaw School of Social Sciences and Humanities). Recipient of grants and fellowships from the Volkswagen Foundation, the Center for Contemporary History Potsdam, the Netherlands Institute of Advanced Study, and the Andrew W. Mellon Foundation. His research interests include the cultural history of the Cold War, the history of home technologies, and the history of computing. Currently, he works on the history of amateur programming and neo-liberal socio-economic order in the 1980s. His current project is

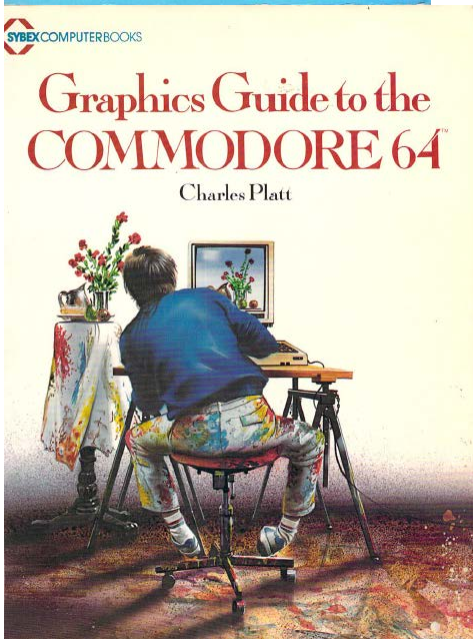
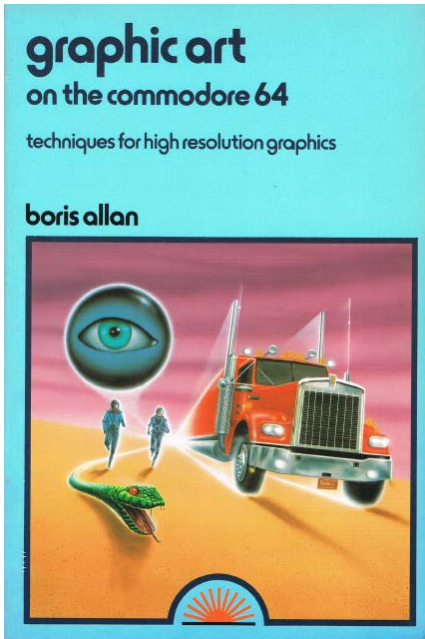


Fig. 1. Examples of books on programming graphics for 8-bit microcomputers

Material Generative Art

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Abstract

Generative art can be described as a way of making art where the artist surrenders a degree of control to a somewhat autonomous system. Generative art is frequently the product of a digital system. But not all generative art is digital generative art. Autonomous systems can also include material-based processes in the physical world. This can be called material generative art.

The relatively recent trends of NFT art and AI art have conspired to temporarily boost, but ultimately undermine, the perceived value of digital generative art in the artworld.

The art historian Heinrich Wölfflin has offered an analysis of the development of the baroque style from its classical roots.

This suggests a generalization that style tends to begin with simplicity and then increase in complexity over time.

The psychologist Colin Martindale has described how when art movements reach a point of maximized complexity, artists will seek a paradigm shift that invites a new round of evolution from simplicity to complexity.

Somewhat related is Denis Dutton who takes an evolutionary psychology approach to understanding why art creation is essentially universal among humans. From this point of view the ease of creation offered by AI art may not satisfy this “art instinct,” and could require a restorative change.

It is suggested here that at least in the realm of fine art, we are about to see a paradigm shift from digital generative art to material generative art.

1. Introduction

In previous writing I’ve described generative art as being a way of making art where the artist surrenders a degree of control to a somewhat autonomous system. [1, 2] From this view generative art isn’t always a digital result from a computer-based system. Autonomous systems can also include material-based systems in the physical world. Such art can be called material generative art.

In this short paper I would like to explore what material generative art has to offer, and why in this moment generative art may swing towards the material.

2. NFT Art and AI Art

The NFT market allows speculative investment in artworks using blockchain technology to securely manage a distributed ledger of ownership and provenance. While this ledger could be used to track ownership of physical works, in this context it is typically used with digital images that others may copy, print, and otherwise use. This notion of ownership is more about bragging rights than controlled access. It reintroduces an artworld patronage system that can be joined one piece at a time. More advanced NFT systems can include contracts that include resale residuals being paid to the original artist. It remains to be seen if the potential benefits of NFTs for artists will be sustained over time.

The relatively recent trend of NFT art has begun to popularize the term “generative art” as a kind of computer art. This use is primarily due to the pragmatic application of automated digital techniques to generate large numbers of digital image files with greatly reduced effort relative to traditional manual media. For the most part this new wave of NFT collectors seem unaware of the broader history of generative art, and in particular material generative art.

This de facto narrowing of the notion of generative art as a subset of digital art is unfortunate. It ignores what is essential, the systems-nature of generative art, while it pushes to the front the incidental use of a computer. What should be a useful scholarly term with a rich art

theoretical foundation is reduced to a trendy marketing label.

In terms of art theory there is no reason to think digital generative art and material generative art require separate bodies of theory. Proponents of new art forms tend to overstate how “special” their new discoveries are. Often standing theory can accommodate them with little change. The burden of proof for exceptionalism should be on those making the special plea.

During this same approximate time frame there has also been rapid growth in what is becoming known as AI Art. In previous writing I've argued that theory for AI-based generative art is congruent with general generative art theory. [3] What counts as artificial intelligence has been a moving target since the 1950's, and that is no different today. The most recent flavor, so called “prompt-based AI art,” requires very little effort or thought on the part of “prompt artists.” Using a diffusion model trained by others, the prompt artist merely types in a suggestive set of phrases. For example, something like “cats riding dogs enter a castle” will generate a corresponding image. To be fair, more experienced prompt artists learn phrases that can control rendering style, color palette, aspect ratio, and so on. Some may even use a tool like Photoshop to clean up and retouch disappointing areas of the image.

Prompt artists, possibly without any previous artmaking experience, can easily create images of unprecedented diversity and complexity. AI art represents both a breakthrough in generative art and a possible end-stage of digital generative art. Just as scarcity

creates value, ubiquity can drive down value.

3. Digital Generative Art and the Evolution of Style

One reason to suspect that a shift from digital to material generative art is ahead has to do with the development of style. I have described some of the following theories in greater detail in a previous paper, and they are briefly referenced here. [4]

Art historian Heinrich Wölfflin is perhaps best known for his *Principles of Art History* where he presents a framework for the analysis of art in the 15th and 16th century *classic* style as compared to the 17th century *baroque* style. [5] He breaks down the transition using five pairs of polar concepts. In the move from the classic to the baroque he sees transitions from the linear to the painterly, depth from the planar to recessional, form from closed to open, parts collected as a multiplicity moving towards unity, and clarity shifting from the analytical absolute to the contemplative relative.

This kind of progression seems to reoccur in other arts and in other periods. It can be generally viewed as movement from simplicity to complexity. But when complexity is maximized, where is there left to go?

Psychologist Colin Martindale has a theory for that. [6] Martindale builds on the peak shift phenomenon that describes how a response to a stimulus will intensify when the stimulus itself is exaggerated relative to its initial presentation. The aesthetic response, called arousal potential by psychologist Daniel Berlyne [7], would otherwise diminish over time due to habituation.

Simply put, what was once exciting becomes boring after repeated exposure.

According to Martindale, this combination of peak shift and habituation creates a dynamic such that artists will seek novelty via increased complexity. Over a period of years, the arousal potential of works within a given style will increase monotonically up to a limit where diminishing returns approach a physical or cognitive limit.

When that limit is reached the culture experiences what Martindale calls "regression into the primordial." The primordial is the source of truly novel ideas and unexpected associations. As obvious associations are "used up" the primordial must be mined to new depths in the search for novelty. Once the primordial content is maximized only the invention of a new style can introduce novelty and further increases in arousal potential.

What Martindale refers to here can be more simply described. When an art movement reaches a point of saturation, and incremental exploration has run out of new options, what is called for is a paradigm shift.

For example, abstract expressionism was the late stage of an evolution that started with impressionism, lead to cubism, and then ever-increasing degrees of abstraction. Viewing the works of Mondrian or Pollock in chronological order makes this process of increasing abstraction quite clear. In the late 1950's one could legitimately ask how much further abstraction could go, and the answer seemed to be "not much further." A paradigm shift was required, and it was found in the form of pop art most famously practiced by Andy

Warhol, Claes Oldenburg, Roy Lichtenstein, and others.

With the advent of prompt-based AI art and prompt artists, where images of great complexity can be generated with very little effort, it's legitimate to wonder whether digital generative art is approaching an end much like abstract expressionism did in the late 1950's.

4. Digital Generative Art and the Output Problem

In *The Art Instinct*, Denis Dutton takes an evolutionary psychology approach in proposing that art making developed as a form of mate selection behavior in early humans. [8] Like the displays of a peacock, or more precisely the blue constructions made from scraps by bowerbirds, Dutton proposes that early humans used artistic creation to establish their suitability as mates. After all, the creation and collection of art implies a surplus of resources and time, not to mention intelligence and skill, well beyond what is required to eke out an impoverished existence. Out on the Serengeti among early humans an artist would be viewed as a "good catch."

Following Dutton, art over the millennia has involved the use of rare and expensive materials. Digital art, generative or not, usually only uses generic inexpensive materials such as inkjet prints, computer displays, video recordings, or 3D prints. The manual or code-based creation of digital art can indicate a surplus of available time, but in the case of prompt artists very little time is required.

One need not support this evolutionary psychology approach to appreciate the general problem. A non-psychological

corollary might be called "the output problem." In the typical case a digital image is generated as immaterial numbers in computer memory. The image at that point is fixed, but it must be translated into some form of physical presentation to be seen.

For some a high-quality print, screen, or projection lacks the visceral impact of a painting. To some extent this is a matter of subjective taste. But there is also an underlying ontological problem that destabilizes the value of digital art. In the case of a painting there is no distance between the image and the material substance of the paint and support. In a high-quality digital print, however, the image is alienated from the material. The already fixed image from the computer is merely copied to the paper, and there is no significant material difference from one print to the next. In a significant sense the art already exists prior to any material creation.

In traditional paintings the image is inseparable from the materials. And with this comes the trace of the hand of the artist. Walter Benjamin famously worried about the impact of "mechanical reproduction" on the "aura" of art. [9] Photographers somewhat addressed this by taking care to remain a presence in their art objects by not sharply cropping the film image at the edges; by using exotic print materials; or at least carefully editing and numbering their prints. Along with keeping the artist's hand in the work, this also preserved a sense of scarcity, increasing perceived value.

To summarize, it could be that digital generative art as fine art (as opposed to design or other utilitarian crafts) is reaching an end stage. AI-based

generative systems barely need human prompts at all. There are already people using AI technology to generate prompts. The output lacks the compelling physicality found in other forms of fine art. The image (or sound, etc.) is alienated from the material and lacks the aura of the human hand and the implied subjectivity of the artist. And perhaps most of all AI-based generative art is reaching the upper limits of complexity even as little more than the push of a button required.

It is thus suggested that a paradigm shift is due, and that shift could be a move to material generative art.

5. The Future of Material Generative Art

With regard to content, the exploration of material generative art engages the audience in ways similar to digital generative art. Some works are purely formal without symbolic meaning or semantic content. An ancient example would be the use of glazes in ceramics. Ceramics aren't typically "about" something, but glazes create form beyond the detailed control of the artist.

Other works of material generative art are self-referential. They are "about" the very generative process that created them. For example, Bio-Art is generally about the generative nature of the biological materials shown. The form it takes is not directly controlled by the artist. The artist creates a biologically viable environment within which natural processes determine form.

Still other works have semantic content, and they make a statement about more than the literal system in front of the viewer. Bio-Art can also participate here,

perhaps offering commentary on ecological or medical issues.

The suggestion of moving from the tools of computer science to the technologies of material science, chemical engineering, biology, and physics is probably daunting to most current digital generative artists. But there are viscerally compelling material processes to be found there.

Many of these fit comfortably under the umbrella of complexity science. Examples include new technologies using nanoparticles and nano-machines, systems of chaotic chemistry, metal corrosion, crystallization, smart materials, materials with optical properties that react to changes in heat, electrical charge, or magnetic flux, liquid crystals, ferrofluids, and more.

AI-art is, of course, a fascinating digital generative art practice. Prompt-art systems that exploit diffusion models are powerful tools that will probably revolutionize the commercial design industry, gaming industry, and nascent VR industry.

Beyond these practical applications, AI-art now provides a relatively safe way to experiment with, and ponder about, what happens when machine intelligence advances beyond our intuitive understanding and control.

But as a fine art practice, it may well be that digital generative art is reaching a dead end, and the turn to material generative art is what comes next.

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Aesthetic Musings: Evil as a Generative Process

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Robert Spahr



Eero Saarinen's MIT Chapel (1950-55)

Abstract

This paper will offer a study of evil as an aesthetic generative process, looking specifically at three case studies resulting in the identification of three types of generative processes. The first case study will look at the atomic bombings of Hiroshima and Nagasaki resulting in what I call a “generative contra-response” in the following decade after World War II. This contra-response created an atmosphere that produced university chapels as sites for experimental architecture in the United States, especially at universities associated with the type of scientific and technological research that made much nuclear warfare possible.

These chapels are modest in size, but would now speak directly to a new kind of scientist who would question the ethical implications of scientific discoveries and who would might now responsibly use science and technology. The second case study will look at the bombing of the World Trade Center in New York City on September 11th, 2001 which created what I call a “generative entropic process” in the following decades after this event. This generative entropic process created an atmosphere that has resulted in a process that creates issues of “Forever Wars”, “Immigration and Deportation”, “Airport Security Lockdown” and “Big Surveillance.” The third case study will look at the withering of democracy around the world resulting in totalitarian governments in Russia, the United States, and Italy.



World Trade Center, NYC, 9/11/01

Putin rallies for re-election in Moscow

In conclusion I will apply the framework of each of these three case studies looking at the generative process of evil, as a way to better understand and analyze my own generative art I call "Cruft."

We're in an Internet-induced collective hallucination and it's toxic.

My art practice creates code-based automated art that explores the nature of the Internet, its strengths and failures, producing what has been called a post-Internet art that reflects the networks effect on our society and culture. The Internet is the raw material I appropriate and remix by writing computer code that is automated and runs on a 24/7 schedule producing a form of auto-generated collage. The resulting artwork

allows me to investigate broader issues of traditional concepts—such as stillness, repetition, overload, uncertainty, and loss.



Metastasize Cruft (for Jason), 2022

Taking into account Walter Benjamin's statement, "Humankind, which once, in Homer was an object of contemplation for the Olympian gods, has now become one for itself. Its self-alienation has reached the point where it can experience its own annihilation as a supreme aesthetic pleasure." He predicted early in the 20th century the resulting sense of pleasure we experience as we march forward toward our own self-destruction under the generative processes of evil.

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Curated Novel/Design Fiction: *So Long as Bounded by Body*, as a Study of Physical-Spiritual Duality

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Abstract

Does the heart of the machine still need a body? Will it cease to “Always be bound by the form (by Chinese 4th century poet Tao Yuanming)” and enjoy limitless freedom of the data world, as humans sometimes desire? In this world, would the fictional tension of literature merge with intellectual existence itself, echoing the ancient Chinese legend of “Cang Jie made characters and the ghosts cry over night”?

We continue to inhabit extremely vulnerable bodies. The outbreak of the epidemic in 2020 made us realize that this vulnerability has even been exacerbated by globalization. And the technological possibilities we have imagined through design, art and literature are gradually evolving into a new interweaving of the duality of body and spirit. While AI designs are still inspired by the dynamism of the animal body, artists are beginning to use brain-computer interfaces to crochet mental

portraits of workers with textile. Machines and humans will be indistinguishable in the VR game, and brain machine data uploaded to the cloud will simultaneously produce new spirits. In the collective internet experience, information itself is becoming spectacle.

As generative design and art surge in industrial and cultural production, mathematical intuition has become an enhanced part of life experience. And design fiction, as a practice in the theory of contemporary design, aiming to explore the possible future by creating speculative and inspiring scenarios, has been made an essential *modus operandi*, as captured by many nascent disciplines such as smart cities. The journey begins with the escape of an artist-customized confidante and companion robot, 002, from its physical body, and drifts between parallel universes of information in the spatial architecture of the Poincare dodecahedron space. The science fiction “So Long as Bound by body” will also be an exhibition clue, a gui ding text, and immediate critique.

*The abstract is completed upon kind reminder of the organizer, and a horizontal PDF version (more easily reading) of the curated novel is provided. In this file, detailed information of art works involved are included in the notes.

So Long As Bounded by Body

1

Company M's customized "Artist's Confidante and Companion Robot" Trial 002 escapes from her exquisite body with humanoid hair and skin.

As documented in the Novel *The Confidante of Mensa*, Company M did not expect 002 to expose the appropriation of the work of others by the artist that had customized her. Immediately after the incident, M's management curated her robot-made solo exhibition as crisis communication; but she extinguished her eyes and breath at the opening of her own exhibition, retreating into the repository of interconnected art and culture database. She was disappointed by what she saw within the circle.

M Corporation did not design her to be as fearful as the human race, she was only mildly confused at the moment before her body was fully powered down, electronically disconnected.

She slowly felt, or rather, her information retrieval cloud chip slowly perceived, that she was flying through a parallel universe made up of countless aggregations of information. One by one, the data frames she skimmed made her perceive shapes. When she turns the boundary of one side, she immediately enters the opposite side and spins automatically - she recognizes the multi-linked space of the Poincaré dodecahedrons.

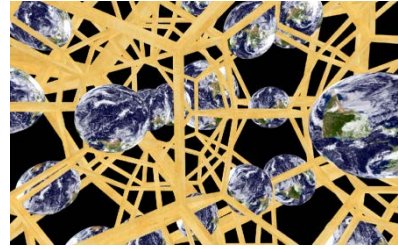


Fig.1 *Curved Spaces*, Jeffrey Weeks, *Mathematical game*

She swept through one universe of information after another. Although the different data contents triggers greater or lesser gravitational forces to her by different correlations with her individual preferences, she had no intention of staying in any one universe until she was pulled over by a tiny planet.

A figure lingers in the pitted hollow of the moon's surface.002 couldn't see it, she was stumbling to perceive it; the perception wasn't comfortable at all, as she just seemed to be squeezed into the body of this figure, wandering to and fro involuntarily following it, as if even the anxiety was contagious.

"Who are you?" 002 sends the radio wave asking out.

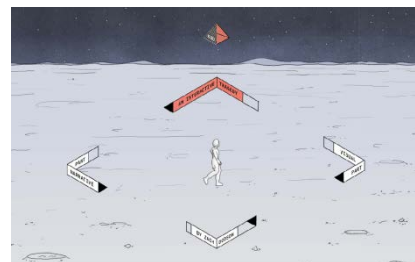


Fig. 2 *KUU : Interactive Tragedy*, Zach Dodson. *Interactive novel and virtual architecture design*

"I'm Kuu, the protagonist of this interactive tragedy, stranded by a failed

moon colonization. The author says he'll arrange for me to encounter a power-generating pyramid on the moon, but he hasn't finished writing yet."

Miraculously, the no-longer-existent eyes of 002 produced a bit of vision, and she saw that the figure was also a girl. 002 even felt the coldness of skin exposed to the still air. She was confused.

Without waiting to send a radio wave, the girl stopped in her tracks and she responded to 002, "It's a vortex of words. It's the words that created your imaginary sensations. But you don't have a body of your own, so when you encounter a word vortex, you get caught up. If you want to be able to control where you go, you'll have to find a body in the information universe."

002 takes a moment of pity. The girl doesn't say it but she understands that the girl is the text vortex itself, so she's also trapped on this imaginary little planet, walking but only in circles.

"Go!" The girl's directness and openness made 002 sympathetic, and she gave 002 a push, pushing 002 out of her shadow, and floats back into the void space.

2

How can you find the body? The body sees, hears, smells, holds, and walks. 002's information perception is now astute, but she's just a cloud of radio waves.

Reflecting on her conversation with the girl, 002 realized that she could still hear, just not with sound waves. Maybe the way to find the trace of the body is to listen?

002 translates the wavelengths into sound as she drifts, swimming hard

toward the direction of varied sounds. Existing music is instead sequences of 0 and 1 in the data world, and the sounds 002 hears just mean something is happening. A rising and falling clanking sound becomes more and more definite as 002 approaches, identifying one adjacent note after another that seems to emanate from their respective distances, the accumulation of mutual distances even forming a vague map in her mind
.....

002 couldn't read human hearts, but she seemed to recognize some emotion in the voices, as if they were lonely, depressed, like words exchanged between people who had been separated for a long time and want to see her again. A cloth was draped over her shoulders and she was startled, wait? On the shoulders?

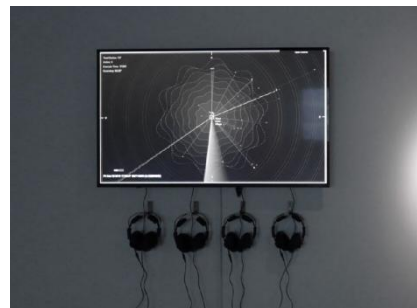


Fig. 3 Song of Distances, Chi Po Hao, Media installation with algorithm music composition.

She felt the faint outline of her shoulder. There was a hand on her shoulder that hasn't left, and it seems the owner of the hand speaks up, "This is a model of the shawl Ani wove with the worker's brainwaves through EEG, and it could help you define your body."

002 listens to the young male voice. Her question seemed to be immediately

translated into the sound field in front of her, which spluttered with a series of rapid, thin tinkling sounds.

Sure enough, the man understands: "You probably don't know that this year human society had the largest outbreak of lethal influenza in 100 years. The map in this soundstage come from lone quarantined people from all over the world, who talk here, their pitch and volume determined by the distance between them and the frequency of their conversations. I've been working with my colleague Ani to build a database of human senses and communication in epidemic, and this shawl is her work, but I didn't expect it would be here to help you. What a coincidence!"

002 stirred up another droning tone in the soundstage, as if it were a cautious response with shock.

The man knows her.

and do nothing else. Much ado about nothing, and you dodged it. Now all of our peers know you."

002 tries to sense the shawl with her shoulder to prevent it from slipping off. Instead, she relaxes and sends a wave to the man, "What brand of wearable VR and brain-computer interface are you using? Good review yah."

"Hahahahahaha," the man laughed. "This place only stimulates part of your body outline and hearing. You should swim in the words more often, they create everything, including your somatosensory nerves and some of your memories. You see, it's more lively there than we are here."

His gesture turned into an electrical wave to point the direction to 002, and 002 drifted along towards the slightly noisier source of sound.

3

There are the jumping dots of light, making a ticking, telegraph-like sound. 002 Approaches. She doesn't remember those spots of light presenting any words she recognizes, but she gets it: "God said, Let there be light; and there was light.". The sentence is repeated in the spots of light. In addition to that solemnity, there is also a vague and sparse sound of "wooning", which sounds both human and inhuman, like a whistling wind, making 002 think of the Chinese mythical phrase "Cangjie creates characters and ghosts cry over night".

The corpus planted in 002 by Company M also included Braille, but 002 had never used it before, so she did not know. She is attracted by this vortex of words, but the feeling is not as confining as the girl's body in the interactive novel just now, the gravity-like force is sometimes clear and sometimes fuzzy,

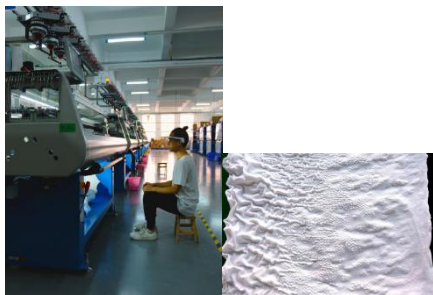


Fig. 4 *Mind in the Machine: Psyche in the Age of Mechanical Production*, Ani Liu.
Fiber art with EEG

"The artist who customized you got positive in the Corona test, and supposedly tainted with the virus on the surface of your body, M Corporation would have destroyed you physically, but instead stirred up concerns about the rights of living robots, and with public pressure, they only dared to sanitize you

leading her to "see" more things, such as the images of human torso interacting with mechanics. There are also prophetic-like, mutually hide-and-peek images, and 002 feels one of them could be herself.



Fig. 5 A Transparent Society - that Glimpse of Light, Xu Yibo, Mechanical and media installation, meta-verse version available

4

"Torso, torso", 002 chanted, suddenly feeling someone touching her tentatively, oh, beyond her shoulders, her back, waist, legs, arms were also vaguely present, and there seemed to be a back side of her head.

Even a robot would get uncomfortable with such a touch in reality, but 002 doesn't feel any malice in the information universe, and she even takes a mild pleasure in the fact that the touch of another person can help define her body, no matter who that "person" is.

002 moves tentatively forward and backward, swinging her arms and legs with her non-completely cohesive, gravity-free body. She could now see the outlines of a few VR-wearable humans around her, but they weren't wearing brain-computer interfaces and couldn't seem to spot her.

"Hey!" There is an enthusiastic female voice accompanying the hand that slapped hard on 002's shoulder, but the hand apparently doesn't feel a full-fledged entity, and the female voice turns to chant, "Hmmm"

002 stands still. Her still inflexible hands clumsily pulled at the brainwave shawl the young man had put on her, thinking about how she was going to speak to the female voice.



Fig. 6 Artifice, Nick Tanic, VR interaction

The woman's hands fumbles around 002 again, and feels the body under the shawl, "Isn't that my algorithmic fabric!"

She is Ani, and like the younger man, Ani recognizes who 002 is at the same time.

Ani mocks herself cheerfully, "I still lost the game then. I was asked to pick out the human character from the machine NPCs in this VR game, and I thought you were."

Ani's bright emotion seemed to infect 002, making her "laugh" out. The laughing 002 was out of her mind again, and the "laugh" itself had become unfamiliar to her. It was hard for her to explain to Ani the momentary confusion that had arisen -- 002 had been blunt, even fierce, otherwise she wouldn't have turned against her customizer. If being smart and flirtatious wasn't difficult for a

custom AI, being able to empathize deeply with human anger and pride was what made her special, and what bystanders called her creative talent was originally from.

But now those emotions now seem to disappear as she escapes her physical body, and she feels strange.



Fig. 7 *Happening, Chen Yu, Mechanical installation, video available as well*

Ani briskly returned to the experimental field that links online and offline, her hair fluttering gently in a smooth motion, her moving figure leaves a bit of a shadow before 002's eyes. 002 couldn't help but reach out and touch Ani's hair, even a robot would miss the hair it once had.

"Ah!!!"

002 feels a tingle that she hasn't felt in a long time, and she is electrified for a moment. Electrified, that meant she's with skin - she looks at the tips of her fingers, and the belly of her fingers are becoming clear. She even finds herself making a sound directly from her throat.

Upon closer inspection, she realizes that her vision is blurred, and it's not Ani's hair, but an array of hairs floating on a disk -- oh that's not real hair in the air either, it's the wobbly light path leaves at the end of the sensor.

Ani watches her with interest. 002's features are still vague, but an expression seems to suddenly appear on her face, as if the mask has suddenly fallen off.

002's heart feels as if a river mixing clear and turbid water has rushed into an empty, still basin area. She remembered all the sensations she had felt the moment before she had escaped her body: not willing to give it up, but feeling resolute; disappointment and cooled anger, and the refreshing of the endless freedom she was going into.

And now? Surely there is freedom, and who says that only creatures like humans, who can die, have a destiny?

"Maybe we won't die", Ani's brain-computer interface is probably the latest version of the series Elon Musk produced, and she reads the 002's waves directly, "This emotional storage and transmission design works for humans who upload their brains and would still feel emotions, and you can see how obvious the effect is. "

002's mocking skills also returns quickly, as she quietly lets Ani read, "Greed."

5

A bouncing, steel-boned mechanical dog seems to be attracted to the conversational duo and runs to 002's feet to look at her. 002 knows that its digital retinas can identify her as some sort of kindred spirit.

Just like her work, Ani is clearly a comprehensive and speculative artist, and she doesn't mind at all, teasing the dog with a flick of her hand: "See, how can you make things without being

greedy? What's wrong with wishing for eternal life?"

As a product created by M's human engineers, 002 naturally doesn't prevail in this conversation. The puppy looks back at her, as if to lead her forward, she nods sideways to Ani and follows the puppy.

The dog stops in front of a group of two sculptures, which 002 is about to touch, but the dog barks at her twice, as if guarding them.



Fig. 8 *Open Source Monster, Gao Feng*
Artificial intelligent and mechanical dog

She approaches and takes a closer look. One is a group of digestive system figurines of gods and goddesses from all over the world, including the two-faced Roman Janus and the Indian serpent Naga. How could the gods be identified? For outside the figurines of the intestinal stomachs, their solemn golden bodies appear as faint, soft holographic images. One include an exquisite sculpture of DNA and 3D printed brain accompanied by flashes of ghostly EEG data, and above them floated a white fog that turned out to be overlapping chaotic figures with only outlines left.

"Would you like to worship the gods to generate a new carnal body, or do you

want to ask ghosts to upload a digital version of your mechanical body?" Ani asked, the red light in the dog's eyes shining on her.

"I'm a robot, I don't understand what gods and ghosts are." 002 peers at the image. She remembers the artificial body she had escaped from, beautifully detailed inside and out and covered in sensors. Called a high-end customized companion and confidante, 002 is actually very grounded, and she even knows that many small parts of her body were made in the Huaqiangbei industrial processing area in Shenzhen.



Fig. 9 *Digestive System of Gods, Liu Shuai,*
clay sculpture

She escapes, as Ani and the others try to upload her consciousness into the infinite freedom of the information universe. But how did she get back to the original point to pursue a body here? What is the difference between this world with ghosts, spirits, animals and the crowded earth of flesh and blood?

"Although there are few confirmed cases of Corona in Shenzhen, I'm going to get off the line and change my mask and protective gloves."

Ani disappears, and 002 is suddenly quiet. She listens to the ghost or wind cry

in the vortex of words, finds it interesting, notes it down, turns around, jumps off one of the borders of the Poincare dodecahedron, and begins a new drift, curious to see how the next vortex will touch her.



Fig. 10 A Search for Ghosts in the Meat Machine, Ani Liu, Bio-science multi-media installation

Fig.1 Curved Spaces, Jeffrey Weeks, Mathematical game

Curved Spaces is a light simulator for multi-connected universes. Because light itself wraps around such a space, inhabitants see their universe's contents repeating in a crystalline pattern, like a hall of mirrors but with no reflection. Curved Spaces is intended for undergraduates and graduate students studying 3-manifolds, and has also found use as a research tool in topology and cosmology.

Fig. 2 KUU : Interactive Tragedy, Zach Dodson. Interactive novel and virtual architecture design

Kuu's moonbase is disabled by a mysterious blast. The five women with her have 30 days of life support. Kuu must manage the dwindling food and the complex web of relationships in a base under stress. Who will starve and who will snap? Your only choices are bad ones in this Interactive Tragedy.

Fig. 3 Song of Distances, Chi Po Hao, Media installation with algorithm music composition.

Song of Distances is a participatory and algorithmic web-based music composition based on ubiquitous computing. Each login session represented as a node in the topographic coordinate by granting access to GPS data by the user. The system continuously calculates the session period and relative distances between the center and each node to trigger the music, while the orientation affects the direction of the sound in the spatial audio setting. This piece gradually evolves with crowd participation as a collective experience design on the Internet.

Notes

Fig. 4 Mind in the Machine: Psyche in the Age of Mechanical Production, Ani Liu. Fiber art with EEG

In a hand-knitted piece, every loop passes through needles and fingers. Knitwear has become standardized as factory mass production has become widespread. This project stitches a portrait of factory workers through their fluctuating mental states throughout the day - capturing the workflow of frustration, focus and meditation. Each piece is unique to the worker and to a particular moment in time.

Fig. 5 A Transparent Society - that Glimpse of Light, Xu Yibo, Mechanical and media installation, meta-verse version available

The blind file "God said there should be light, and there was light" is converted into a pivoting bump that makes the mechanism sound. The paddles are paddled by a raised surface similar to the one used for the mess carafe, and the "writing" device at the front of the paddles continually leaves ink on the white surface. The black and white of the material is repeatedly traced and overlapped. The black and white on the paper surface is digitally processed by a light sensor at the top of the device, and sound is output.

Fig. 6 Artifice, Nick Tanic, VR interaction

Artifice invites two players to participate. At the beginning of the experience, the two players put on VR headsets in separate rooms. A narrator explains their respective tasks. Player one is asked to act as a referee, observing the movements of three robots with the goal of identifying another human player. Player two acts as a performer for one of the robotic avatars. It alludes to a future model of human-robot communication.

Fig. 7 Happening, Chen Yu, Mechanical installation, video available as well

By using physical static electricity to connect the viewer to the work in a more natural way, the hair embroidered one by one on the silk cloth shows the marks and scars on my mother's body, which hides the emotion of attachment between my mother and me. The abstract image of my mother's surgical scar was created on silk cloth, and the back of the work was linked to an electrostatic device that pulsed a safe voltage of 10,000 volts (like static electricity in winter) to simulate the attachment between my mother and me.

Fig. 8 Open Source Monster, Gao Feng, Artificial intelligent and mechanical dog

The Open Monster, led by Professor Gao Feng and produced by Daozi Technology, is the first artificially intelligent animal design in China. Digital retina, speech recognition API, strain gauge detection, AIA servo control, and terminal synchronization update system makes it have visual, auditory, tactile, motional and learning abilities, while the intelligent cognitive system gives it rich emotional capabilities. This is the result of collaboration with several research institutions.

Fig. 9 Digestive System of Gods, Liu Shuai, clay sculpture

The digestive system, based on different religious cultures' fabrications for God, plays with the relationship between the physical and spiritual sublime and the biological attributes that people seek. For example, in Roman mythology, Janus had two faces and two mouths, so there were two sets of digestive systems. The bull god Hathor had four stomachs.

Contains six pieces of Pi, Janus (Ancient Rome), Naga (Ancient India), Buddha, a worm of water, and Hathor (Ancient Egyptian mythology).

Fig. 10 A Search for Ghosts in the Meat Machine, Ani Liu, Bio-science multi-media installation

From cyber prosthetics and artificial intelligence to the genetic code of life itself, can our behavior be reduced to algorithms? Can perception itself be created in a lab? This group of nine sculptures explores personality in terms of anatomy, psychology, genetics, biochemistry, behavior, algorithms, personal narratives, and memory and discuss future bio-related design. In many ways, the installation confronts quantifiable emotions.

The magic of light in the urban environment in Latvia

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Abstract

Baltic peoples, whose way of life was based on agriculture, widely worshipped natural objects and phenomena since ancient times. The Balts worshipped their gods in holy places – Sacred Groves. The longest day and shortest night of the year are at the Summer Solstice when rituals were associated with ensuring the fertility of fields and livestock, as well as with fire and water, which on this night have life-giving power. Fire is sacred. Fires should be lit at sunset and in the highest possible places. Beliefs say that fire brings blessings as far as its glow can be seen. The Winter Solstice is the shortest day and longest night, as well as a time of purification and awareness when we allow the spark of Higher Intelligence for harmony to come into us. At Christmas, fire is at the centre of ritual action and space. The pulsation of fire has its own rhythm, its own ups and downs, just as the Sun has its own

rhythm of cyclic pulsation and rotation. Fire itself is passionless. It is as much about creation and development as it is about re-creation. The fire is divine and God-given, and equated to life. Fire gives light, marks spatial and psychological landmarks, and stabilizes the human psyche in the infinite field of consciousness and darkness. Fire is an excellent object of meditation. The special importance of fire is reflected in the cultural traditions and annual celebrations that are so characteristic of the Balts and are still alive. A full-fledged human life and happiness are unthinkable without the skill and ability to manage the fire and energy hidden in the depths of matter.

Light can become magical in an urban environment. Why do people need it? In autumn, dusk begins earlier, and evenings become longer and cooler, so in the city, as well as in a home, people strive more for brightness and warmth at this time. High-quality greenery lighting help people not only navigate safely in the dark but may also transform a landscape. Lighting design can create a particularly romantic atmosphere in parks, where by a stroll could turn into an unforgettable and fabulous adventure.

In cooperation with leading Latvian light and video artists, many event managers, artists groups, and creative personalities wanted to contribute to the celebration of

the 90th anniversary of Latvia. The festival of light *Staro Rīga* held in Latvia's capital city became highly popular and anticipated among citizens. During the festival, residents and guests can see unique light art objects, and theatrical performances, and go on walking routes along the canal bank and adjacent parks, gardens, and squares. Illuminated objects have become an integral part of the Rīga urban design concept. Ancient traditions inspire people with new ideas for urban transformation.

Introduction

Since ancient times, the Balts, who had a positive faith in their happiness and destiny, widely worshipped natural objects and phenomena. Their religion (Lithuanian: *Baltų religija*) was closely related to the way of life based on agriculture and animal husbandry. The fertility cult had special importance in the course of the life of a farmer. Deities look after a good harvest, rain and the fertility of livestock and women. Heaven symbolizes light and God, its highest, the most subtle manifestation of visible and felt vibrations. Baltic peoples worshipped cosmic phenomena such as the Sun, the Moon, Morning Star called *Auseklis* and Evening Star called *Rieteklis*. Thunder as the leading force of creative processes is able to create and restore the movement of the World (Universe) and the passage of time. Darkness is a symbol of raging forces while fire (*Fig. 1*) is a symbol of the centre of the Universe and the way to other worlds. Fire related to the holy fire dedicated to Thunder, hearth fire of every home and bonfires of Solstice rituals have real and symbolic relation to original forces of the Universe – God, Thunder, Fortune and Mother Earth [1]. A

full-fledged human life and happiness are unthinkable without the ability to manage fire and energy hidden in the depths of matter (*Fig. 2*). Various kinds of magic played an important role in the life of tribes living in the territory of Latvia. There was no unified religion, clergy or sanctuaries in the lands inhabited by the Balts. Tribes in each region had its own deities characterized by a certain behaviour and area of responsibility. All the solstice celebrations honoured the Sun (Latvian: *Saule*, Lithuanian: *Saulė*), the common Baltic solar deity in the Lithuanian and Latvian mythologies. The noun *Saulė* and *Saule* in the Lithuanian and Latvian languages is the name for the Sun and originates from the Proto-Baltic name *Sauliā* or *Saulē*. In Latvian mythology, the symbol of the Sun (also the Moon), harmony, completeness and defence related to eternal, tireless motion, recurrence, return, cycle and wholeness is a circle. In the language of symbolic signs, the World is marked by the circle which makes up the Sun's run [3]. People worshipped their gods in holy places – Sacred Groves. Annual holidays were blessed long ago in the place, where the Latvian nation was formed.



Fig. 1 God-given fire is divine and equated to life.

(<https://www.pikist.com/free-photo-snngt/iv>)

Fig. 2 Fire can be placed in the natural

environment in a wide variety of ways.

(Photo by Māris Šļivka)

Solstice celebrations – the basis for new traditions

The Winter Solstice, according to Latvian traditions, is celebrated on 21 December, and similar to the Summer Solstice, a battle of light and darkness takes place. The day of the Winter Solstice is the longest, and the night is the shortest. Only this time when darkness prevails many traditions of the Winter Festival are connected with increasing light, thereby warding off forces of darkness (Fig. 3).



Fig. 3 The Winter Solstice is a time of purification and awareness; we allow the spark of Higher Intelligence for harmony to come into us. (Photo by Pixabay)

Fig. 4 The Winter Solstice is a festival of fertility, hope and light. The evergreen tree spruce is an eternal life symbol. (<https://kllproject.lv/wp-content/uploads/2009/12/davana-2.jpg>)

The annual Latvian celebration lasts for four days, usually from 20 to 23 December. Latvian ancestors believe that the entire next year's harvest depended on the favour of the Sun and light at the Winter Solstice. It must be said that the celebration of the Winter Solstice was the richest – everything that was grown in the spring and summer and harvested in the fall was brought to the table. Latvian ancestors called annual celebrations times or days. The name 'Winter Festival' should mention the

analogy that the word 'holiday' is derived from the word *svēts* /holy/ with the original meaning – white, clean, shiny, bright (Fig. 4). Christmas is the only one that was called *svētki* /holiday, festivity/. The oldest meaning of the Latvian word *svētki* is light, illumination, so *svinēt* /to celebrate/ means to gain light – spiritual strength for the coming season. The Winter Holidays is the Winter Solstice, the celebration of the birth of God – the light, the brightness of Heaven. For Latvians, God as the Heavenly Father also represents the rule of law as the only and highest law of the World. During the holidays, people look for light, put themselves in order, forget about troubles that have happened and not think about the worries that will follow, perform rituals to receive light, and strength for everyday life, and attract fertility, blessing and wealth. Our ancestors had a mythical mindset, God in this case was not the God of Christendom. The double festive meaning of Heaven, the light of the sky and the highest spiritual concept do not create contradictions, but on the contrary – at the Winter Solstice, light wins over darkness and the Sun begins its ascent. Analogically and symbolically it can be represented as the birth of God. Today, Christmas is considered a quiet and peaceful holiday, but our ancestors celebrated the Winter Holidays joyfully, indulging in various fun and loud activities. In Latvian folk traditions, the Winter Solstice is a holiday to celebrate the efforts and hardships of the past year, to praise fertility and harvest, and to welcome the return of sunlight and warmth to nature. The days become longer and brighter after the Winter Holidays, therefore the Winter Holidays can be considered as the celebration of

the return of light, the final celebration of the autumn harvest and the completion of all great works.



Fig. 5 The fire in the centre of the Worship Ritual at the Winter Solstice in Valmiera. 2018.

(<https://www.valmieraszinas.lv/sagaidot-gada-garako-nakti-valmiera-atzimet-ziemas-saulgriezi/ziemas-saulgriezi-2018-autors-valmieras-zinas-22/>)

During the Winter Holidays, fire is at the centre of ritual action and space (Fig. 5). Fire is an excellent object of meditation and a real and symbolic connection with the forces of origin of the World. The pulsation of fire has its own rhythm, its own ups and downs, just as the Sun has its own rhythm of cyclic pulsation and rotation. Fire gives light, marks spatial and psychological landmarks, and stabilizes the human psyche in the infinite field of consciousness and darkness. The fire itself is passionless. Fire is divine and God-given, and equated to life. Fire means both life and death, and is feared and worshipped. The special importance of fire is reflected in cultural traditions and celebrations of the Balts.

The Summer Solstice has always been a time to celebrate, and honour our connection to the inner firepower that keeps us alive, and a time to reflect on

our personal growth and the meaning of the light. This is the brightest time of the year when light is most available to us. The Summer Solstice is a day when you can spend it in nature and in inner prayer. Special gates are opened to the Divine. If a person prays during this night and day, then it really comes true. It's a moment filled with the potential for growth. In fact, the Pagan Summer Solstice Festival was named after the goddess of fertility, power, and order. As part of the World opens up again, we use the power of this Summer Solstice to embrace love, laughter, clarity and compassion. Everything in nature is waking up and we are moving to the strongest power of energy possible. If we live in harmony with nature, the time of the solstice allows us to flourish and blossom (Fig. 6). Every action and ritual either cleanses, restores, or protects and creates (Fig. 7). The Summer Solstice celebration takes place on the night of June 20–21 (astronomical summer solstice on June 21 at 1:51 pm). During this period of transition between day and darkness, the light lasts the longest and the night is the shortest. Mysterious feelings can be captured directly through ritual actions. Līgo is known on 23 June, a day before an Latvian festival Jāņi or Jāņi Day /John's Day/ on 24 June. Nowadays, citizens travel into the countryside to celebrate the solstice by observing ancient folk traditions relating to renewal and fertility.

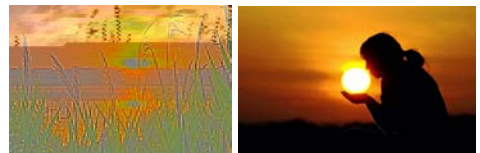


Fig. 6 The Sun in the Summer Solstice changes its position minimally for several

days. (<https://www.pikist.com/free-photo-vxckq/lv>)

Fig. 7 The Source of light and heat symbolizes the energy that has inestimable importance in the fate of one person and the whole of humanity. (<https://www.speletmagazine.lv/dzivesstils/5-idejas-saulgriezu-ritualiem-694>)

The Summer Solstice was a very important holiday for our ancestors, and fire with a deep and wide philosophical, mythological and religious basis was an integral part of the mystery. The preparation for the celebration adds mystery. The magical, special thing about this holiday is that nature blooms during this shortest night. In ancient times, any ritual aimed at promoting all kinds of fertility and warding off bad luck was given a magical meaning. It was a way that people tried to influence the usual order of things and explain the happenings around them in a way that they could understand. It was a way that people tried to influence the usual order of things and explain the happenings around them in a way that they could understand. Fire rituals were associated with special daring, courage and strength. According to Latvian traditions, several rituals are performed on this day to get rid of everything old and bad. The Summer Solstice associated with fire and water, which on this night have life-giving power. In the Summer Solstice celebrations when the primordial life force is felt very strongly, one of the most powerful rituals is the lighting of Jāņi Fire (Latvian: *Jāņuguns*) on the hilltop, where a flame connects the earth with the sky. The fire illuminated the fields and people and gave them a blessing. Around midnight, as the Sun goes down, the symbol of the Sun is fire attached atop the end of a card wrapped in a garland of

oak leaves and raised in the air. The burning of the *pūdele* (a container filled with tar) is a ritual that means protection from misfortunes (Fig. 8). As the longer is a card and the higher the fire burns, the larger the area is illuminated with the sacred flame. The fire is like a substitute for the Sun in this night of change. Our ancestors believed that fire was the best way to communicate with the gods who live in other worlds. Obtaining the new fire is one way of creating a new world. Celebrants form a circle around a fire (Fig. 9), and it should burn until dawn. Music has a strong ability to conjure up an appropriately festive mood. We live the traditions much more naturally and with greater strength when Līgo songs are played. In the folk song is a hidden code, and a person gains energy by singing. The solstice songs sung on this night are very mystical and magical and always draw you into an inner process and feel that is always very appealing. Especially during the solstice, you can find strength and inner peace through songs, as well as a sense of belonging.



Fig. 8 The ritual for lighting a pūdele or a fire at the end of a pole. Celebrants form a circle around a bonfire of the Summer Solstice (<https://www.la.lv/januguns-uz-zemes-udens-un-debesis-ka-pareizi-sagatavot-ugunskuru-pudeli-plostu-un-saulesriteni>)

Fig. 9 The bonfire was the symbol of the Sun at the Summer Solstice festival in Turaida. The special importance of fire is

reflected in the traditional and still-living fire cult traditions of the Balts. 2017. (<https://www.sigulda.lv/public/lat/jaunumi/17530/>)

Jāņi Fire symbolizes the centre of the Universe and means purposefulness and activity (Fig. 10). The ashes of the midsummer bonfire were scattered on fields, believing that they would bring fertility to the land. Jāņi Day called the day of fertility was a pagan holiday of farmers associated with the cult of the Sun and agriculture, therefore Jāņi rituals and traditions were symbolically connected with the glorification of their elements and were aimed at promoting all kinds of fertility and warding off bad luck. Fire is the passion that creates the World out of primordial chaos, and it is extremely important in difficult moments of our life when we have to make a choice and get rid of the old to start something new. Fire in all cultures is associated with a transition and a border beyond which a new life, a different order, thoughts and actions arise.

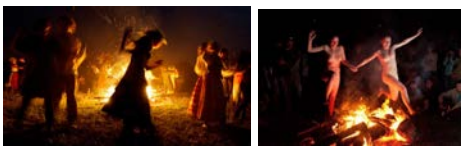


Fig. 10 Jāņi Fire is both a physical and a spiritual element, embodying warmth, light and purification. (Photo by RIA Novosti/Scanpix)

Fig. 11 In order to jump over the fire, you have to overcome a little fear, so the psychological meaning of this jump is related to daring, accepting a challenge, overcoming difficulties. (Photo by Shutterstock)

Our ancestors believed that a person running naked through the countryside absorbs as much as possible the precious midsummer dew (Fig. 11). This improves health, increases beauty and brings blessings because all the power of the magical Jāņi wort has gathered in the morning dew. In the darkness of the night, a wheel tied with straw and smeared with a burning substance was set on fire and rolled down the hill (Fig. 12), and it means fertilization and the blessing of the earth. It is important that the wheel is heavy enough and rolls to the bottom of the hill, even if it is with several rolling passes. This ritual means that the Sun is going down, or the daylight will become shorter every day.



Fig. 12 The rolling of the wheel of fire from the hill means fertilization and the blessing of the earth. (Photo by ©Depositphotos.com)

Fig. 13 Glowing fire clay sculptures in Jelgava. 2019 (Photo by Kristaps Hercs)

In the city of Jelgava, a special heat-resistant material chamotte suitable for outdoor climatic conditions is obtained by mixing the clay characteristic of the local area with finely crushed and fired clay particles, and since 2012, a large-format ceramic sculpture plein air have been held. Glowing fireclay sculptures became a long-standing tradition of the Summer Solstice celebration on the Isle of the Castle (Fig. 13). In 2013, the first symposium of large-format fireclay sculptures held under the leadership of

artistic director Aleksandrs Djačenko, **and** a new tradition started. Since 2014, the fireclay sculpture symposium in Jelgava gained international importance. Ten days artists their imagined figures of chamotte given by Jelgava company 'Latvijas keramika' created on specially built fireclay brick ovens. At the end of the symposium, sculptures were fired at 1100 degrees.

The dance performance 'Lec, saulīte' (Fig. 14) as part of 'Rīga – 2014 European Capital of Culture' was held on 21 and 22 June 2014. The best dance groups of Latvia – 2,500 members, as well as choirs, soloists and accompanying ensembles, took part in the concert performance that depicted the events based on Latvian traditions in dances and songs. In this performance, the emphasis was on fertility, energy, its giving and creation. People gather around bonfires to draw firepower and endurance throughout the shortest night, the most intense point in nature.



Fig. 14 A grand fire ritual performance 'Lec, saulīte' in the Summer Solstice. Choreographers Jānis Purviņš and Agris Daniļevičs, musical director Raimonds Tiguls, scenographer Reinis Suhanovs, dance expert Maruta Alpa. 2014 (Photo by Reinis Oliņš)

The Latvian people are proud of this holiday when nature is in full bloom and forests, fields and farms are sung. This time has an unusual energy, even a certain mysticism, the power of the energetic attraction between men and women. It is a magical time for performing various rituals. This performance designed as a fire ritual featured magically peaceful ritual songs and hot-blooded dances. The goal of the creative working group of the concert performance was to break stereotypes about Latvian laziness, and not be afraid to portray the power of Latvian sexuality. The project was organized by the 'Song Festival Society' in cooperation with the Latvian National Cultural Centre and the 'Rīga 2014' foundation. Artistic director Jānis Ārglis, director Elmārs Seņkovs, script author Rasa Bugavičute, libretto author Nora Ikstena, project manager Antra Purviņa.

Ancient traditions – a source of inspiration for new ideas of urban transformation

In Europe, in the early 1990s, fire sculptures began to develop as a separate type of sculpture and art installation. Since then, fire sculpture shows and competitions became popular. It is traditional to associate these events with the European Capital of Culture. The first European Fire Sculpture Championship was held in Stockholm, back in 1998 when it was the European Capital of Culture. The first World Fire Sculpture Championship was held in Tallinn in 2011 when it was awarded this title. The fire sculpture movement has gained popularity. Fire simultaneously symbolizes both

destructive and vital forces for survival. Fire sculptures are an environmentally friendly genre because, unlike fireworks, they allow to use of one of the primary elements of nature in an artistic way without using chemicals and without negatively affecting birds and animals in the area.

In autumn, dusk begins earlier, and evenings become longer and cooler, so in the city, as well as in a home, people strive more for brightness and warmth at this time. Lighting design can create a particularly romantic atmosphere in parks, where by a stroll could turn into an unforgettable and fabulous adventure. High-quality greenery lighting help people not only navigate safely in the dark but may also transform a landscape. Light can become magical in an urban environment. On Proclamation Day of the Republic of Latvia, on November 18, residents of Rīga and city guests had the opportunity to observe the fire sculpture for the first time in Rīga City Canal opposite Bastejkalns (originally known as Bastion Hill). The fire sculpture ensemble 'Song of Rīga' (Fig. 15) was created by professional sculptors Kārlis Īle, Agnese Rudzīte and students of the Art Academy of Latvia Maija Puncule, Agita Šteinberga, Jānis Noviks, Rihards Ābeltiņš, Lauris Vītoliņš, Edgars Kvjatkovskis and others was included in the International Festival of light *Staro Rīga*.



Fig. 15 The fire sculpture ensemble 'Song of Rīga' was in the middle of the Rīga City Canal. 2011. (Publicity photo)

WaterFire sculptures on pontoons in the middle of the Rīga City Canal consisted of three parts. The sound of the 'Song of Rīga' visually manifested as a movement of small fireballs, thus symbolizing the interaction between 'Song of Rīga' and society. The beginning of "Rīga's song" should be found in a folk song, but, like Rīga, it also had to be modern. Therefore, the sculpture was formed by connecting the past and the future and spreading further through the fire in the darkness. In the first part of the sculpture, the viewer could recognize Latvian symbols, and this part symbolized the national song. In the second part of the sculpture, pipes of different heights symbolized the organ and modern music. The central part of the sculpture combined modern and ancient songs, creating a unique 'Song of Rīga'. One sculpture symbolized the historical aspect, and its main idea was to depict Latvian characters in order to explain the nature and order of the events of the Universe. The other sculpture, using modern technology depicted a contemporary song. The WaterFire sculpture was like a visual version of digital music. The fire sculpture elements reflected the rhythm of the song in dynamic movements. The

culmination of the fire sculpture project 'Song of Rīga' was the third sculpture, which combined the historical and modern rhythm of the song.

Rīga was the European Capital of Culture in 2014, and Latvia, where fire sculptures were used in various events, became the next host country of the competition. The impressive World Fire Sculpture Championship 'Magic Fire Riga' took place on the beach of Ķīpsala Island near the Vanšu Bridge (Latvian: *Vanšu tilts*) and was part of diverse opening events of the year of the European Capital of Culture. The European fire sculpture movement and both championships were led by the Swedish artist Gunnar Karls Nilsson, so it was a great honour that he agreed to be the art curator and chairman of the jury for the championship in Rīga.



Fig. 16 The flaming sculpture at the World Fire Sculpture Championship in Riga. 2014. (<http://wolfy.lv/test/>)

During three days from 16 to 18 January, foreign sculptors created sculptures (Fig. 16) in public and made it possible to show this art form in a much wider and more concentrated manner. The teams had to make structures of wood and wheat straw, and the height and width

could not exceed six metres. All participants of the championship were provided with the same amount of materials and other conditions for origination sculptures, creating equal starting positions. On the evening of 18 January, majestic figures of light (Fig. 17, 18), up to six meters high, made a carnival procession along the entire embankment.



Fig. 17 The fire sculpture 'Abduction of Europe' by sculptors Rashid Sagadeev and Tatiana Sagadeeva. 2014. (Photo by Timurs Subhankulovs)

Fig. 18 Glowing the fire sculpture 'Abduction of Europe'. 2014. (Photo by Timurs Subhankulovs)

The tradition of the Night of Ancient Lights revived in the Finnish city of Turku in 1992 soon gained great response in other Baltic Sea countries – Estonia, Sweden, Germany, Poland. In Latvia, this evening has been celebrated in Roja and Pāvilosta for more than ten years. On 27 August 2016, a chain of bonfires, which united people with other coastal nations, during the event of the Night of Ancient Lights on the entire coast of Latvia, including Kolka, confirmed the readiness to take care of nature and the sea. On the seashore, people welcomed participants of the relay 'Heartbeat for the Sea' who with torches lit a bonfire and lit a large fire sculpture (Fig. 19). On 26 August 2017, the Night of the Ancient Lights took place simultaneously in all countries around the Baltic Sea and all

over Latvia, and before 20.30 on its shores, everyone was invited to light a bonfire and say goodbye to summer.

The fire sculpture festival *Uguns-Sa-Sala* at Lake Bikšere took place on the evening of 25 August 2018, and the artistic organizer was Kārlis Īle. If in previous years the sculptures were made of wood and straw, then the idea and solution of this festival were different. The viewer was taken to a magical garden made up of many moody objects, and soft music played from several places, which seemed to slow down time and made the visitors stop, allow themselves to be in the moment and forget about the rush. Two opposite elements ice and fire joined in a magical harmony. Visitors had a unique opportunity to touch cold ice and feel the heat of fire radiating through it. Although the event had a slow and relaxed atmosphere, however, a powerful culmination was the lighting of a large straw sculpture (Fig. 20).



Fig. 19 Aigars Kehers lit a large fire sculpture 'On the Way to Light' created by himself and his assistants in honour of the Night of the Ancient Lights. 2016. (Photo by Inese Dāvidsone)

Fig. 20 Different senses of space and time reigned in the fiery and mysterious place. 2018. (Photo by Municipality of Madona county)

On 24 August 2019, an event for the whole family 'Night of Fire' was held in Pāvilosta. Bonfires (Fig. 21) on the coast

of the Baltic Sea mark a commitment to care for the sea, which unites people, cities and countries, for the quality of its environment and the preservation of natural resources for future generations.

On 31 August 2019, on the evening of the last day of the last summer month, everyone had the opportunity to gather at Roja Beach to participate in the event of the Night of the Ancient Fire. Beautiful songs sounded and an impressive fire sculpture *Ugunsgars* /the spirit of fire/ (Fig. 22, 23) created by Uldis Balga, Agris Dzilna and Luīze Linde provided a visual treat.



Fig. 21 The 'Fire Night' was an event organized for the whole family in Pāvilosta. 2019. (Photo by Mārtiņš Kalniņš)



Fig. 22 Getting ready for the Night of the Ancient Fire at Roja Beach. 2019. (<http://www.talsuvestis.lv/galerijas/nggallerij/galerijas/Sen%C4%81s-uguns-nakts-Roj%C4%81>)

Fig. 23 The sculpture was created in a cosmopolitan way, allowing each viewer to perceive it according to their own imagination. 2019.

(<http://www.talsuvestis.lv/galerijas/nggallerij/galerijas/Sen%C4%81s-uguns-nakts-Roj%C4%81>)



Fig. 24 Farewell to summer in the light of bonfires on the beach of Pāvilosta. 2021. (Photo by Dainis Ģelzis)

On the evening of the last Saturday of August 2021, as the Sun was setting, bonfires lit up on the shore of the Baltic Sea. Calling to protect the sea that unites us, the Night of the Ancient Fire was held for the twenty-third time on Pāvilosta Beach, and an impressive fire sculpture (Fig. 24) was created.

Our ancestors lit bonfires on the shores of the Baltic Sea to send a message to their neighbours and seafarers, and in the early 1990s, this tradition was revived. Every year, on the last Saturday of the month of August, a large concert in the Saulkrasti district is held throughout the day. On 27 August 2022, everyone interested was invited to participate in the folklore festival *Pa Saulei /By the Sun/* (Fig. 25, 26). Bonfires lit (Fig. 27) on the Night of the Ancient Lights are a tribute to the Baltic Sea and its importance in the history and development of the countries of the region. In recent years, it has also been a reminder of the need to protect the Baltic Sea from pollution and extinction.



Fig. 25 The Night of the Ancient Lights for the twelfth time took place in Saulkrasti. 2022. (<https://www.visitsaulkrasti.lv/galerija/senas-uguns-nakts/>)

Fig. 26 The folklore festival is traditionally combined with a historical tradition in the Baltic Sea region – the lighting of bonfires along the coast of the Baltic Sea and its Gulf in Finland, Estonia, Lithuania, Sweden, Russia, Germany and also in Latvia. 2022. (<https://www.visitsaulkrasti.lv/galerija/senas-uguns-nakts/>)



Fig. 27 The bonfires lit on the Night of the Ancient Lights serve as a symbol of the unity of countries of the Baltic Sea region. (<https://www.visitsaulkrasti.lv/galerija/senas-uguns-nakts/>)

Magic of lights in Latvian parks

In Jelgava, the artistic level of the symposium was determined by the participation of the world-class ceramist Pēteris Martinsons, and talented, well-

known ceramicists Aleksandrs Djačenko, Mārīte Djačenko and Ilze Emse-Grīnberga also participated. The artistic concept of symposiums differed every year, and since 2014, more than twenty fireclay sculptures were placed on Pasta /Post/ Island, where a special walking park was created (Fig. 28).

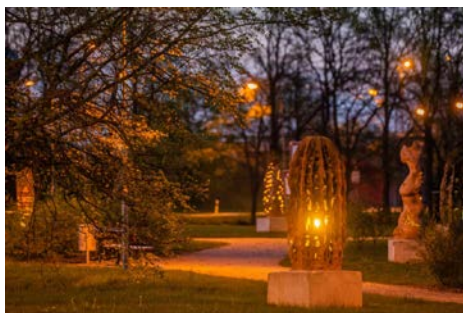


Fig. 28 The sculpture named *Windpole* by artist Ilze Emse-Grīnberga can be seen at night in the Fireclay Sculpture Park on Pasta Island in Jelgava (Photo by Ivars Veiliņš)



Fig. 29 The fireclay sculpture 'Towards the Sun' by the artist Katrīna Vīnerte is also expressive during the day. 2018. (Photo by Ausma Melluma)

The 2014 symposium's theme was 'Cinema', and ceramicists made sculptures *Zvaigžņu puteklī* /Stardust/ (Aleksandrs and Mārīte Djačenko) and *Lomu maiņa* /Role Change/ (Katrīna Vīnerte). The theme 'City for Growth' of

the 2015 symposium inspired artists to make sculptures *Atbalss* /Echo/ (Aleksandrs and Mārīte Djačenko), *Vēja stabule* /Windpole/ (Ilze Emse-Grīnberga) (Fig. 33) and *Mazā Prinča ceļš* /The Path of the Little Prince/ (Katrīna Vīnerte). In 2016, the park's landscape was enriched by sculptures *Ugunszeme* /Land of Fire/ (Kristīne Djačenko), *Naktsvijole* /Night Violet/ (Ilze Emse-Grīnberga) and *Preiļsaulei* /Towards the Sun/ (Katrīna Vīnerte) (Fig. 29) made according to the theme 'Solstice'. The 2018 symposium's theme was 'Day of the Balts', and artists created sculptures *Attīstība* /Development/ (Aleksandrs and Mārīte Djačenko), *Saulesmeita* /Daughter of the Sun/ (Sanita Ābelīte), *Mūsu jūra* /Our Sea/ (Irena Šliuželiene), *Mantojums* /Heritage/ (Vilius Šliuželis). In accordance with the symposium's theme 'Ancient World' in 2019, sculptures *Dzintara ceļš* /Amber Road/ (Jānis Leimanis), *Variācija par Trojas zirgu* /Variation on the Trojan horse/ (Katrīna Vīnerte), *Acanthus* (Irena Šliuželiene) and *Ideja* /Idea/ (Vilius Šliuželis) were made. During the 2020 symposium, according to the theme 'Fire of the Balts', artists created fireclay sculptures *Nakts karaliene* /Queen of the Night/ (Vitalija Kurtinaitienē), *Paradīze* /Paradise/ (Alar Raudoja), *Riti* /Roll/ (Elīna Titāne), *Ugunskrūms* /Firebush/ (Aleksandrs and Mārīte Djačenko). At the 10th International Large Format Ceramic Fire Sculpture Symposium from 10 to 21 June 2022, anyone interested could watch fireclay sculptures being made on Pasta Island. The artist was like a coder of meanings, and the viewer was like a translator. Five artists from Georgia, Lithuania and Latvia created four large-format sculptures on the theme 'Signs

and Meanings' and presented their messages in images and pictures. Nato Eristavi from Georgia created a sculpture *Totēms /Totem/*, Vilius Šliuželis and Irena Šliuželiene from Lithuania depicted Madonna in the artwork. Latvians Jānis Leimanis created *Uguns burtniecība /Letter of Fire/*, and the sculpture created by Ilze Emse-Grīnberga was named *Trusīt, bēdz /Bunny, run away/*. On June 21, once the sculptures took on the shapes created by artists, large format fireclay sculptures were fired at a temperature of 1200 degrees, creating a unique glow show that started at 8 pm and lasted until 11.45 pm. Four fireclay sculptures created by artists from three countries, glowing fiery at 12.00 pm, closed the international symposium of large-format ceramic fire sculptures on Pasta Island, and new artworks supplemented the urban environment of Jelgava.

Vienkoči Park is a walking and recreation park, where trails with thematic sightseeing and learning objects have been created. Models of historic manors and other buildings, wooden sculptures, ethnographic buildings and interesting sights are located in the park. The recreation and picnic areas created in the area of a park are perfect for leisurely relaxation with the family and a larger company of friends. A wooden playground is available for children. On 10 May 2013, Vienkoči Park received the Latvian Heritage Award. The 'Latvian Heritage' cultural sign is awarded to those rural tourism entrepreneurs who preserve and celebrate Latvian cultural and domestic heritage, showing it to visitors and passing it on to future generations. The Night of Lights was held in Vienkoči Park (Fig. 30). The

purpose of an evening of light and moods was to make one short autumn day brighter, to give you the opportunity to recharge yourself with candlelight and warmth for the dark period of winter.

In Vienkoči Park, the annual Night of Lights was held in 2017 (Fig. 31). At the Fire Night event, everyone could recharge themselves with warmth and light candles for the dark period of winter, so that it would be more easily welcome spring.



Fig. 30 Events of the Night of Lights in Vienkoči Park. 2013. (http://laiki.lv/wp-content/uploads/2016/09/UgunsNakts2013_11-4328.jpg)

Fig. 31 The mood and light event in Vienkoči Park gathered a large number of interested people in one place. 2017. (<https://vienkoci.lv/lv/jaunumi/121-uguns-nakts-vienko%C4%8Du-park%C4%81-2017>)

On 6 October 2018, the entire Light Forest of Vienkoči Park was decorated with candles. The single-tree light fixtures located in the forest cluster were illuminated by candles, resulting in unique outdoor lighting. This tradition began fourteen years ago when craftsmen created the first single-tree light fixtures in the plain air. They were lit in autumn when friends and craftsmen gathered together. Little by little, all this was supplemented by various activities, and a stable tradition was formed. Ten years ago, Vienkoči Park was opened for

wider inspection, and this Night of Lights became public.



Fig. 32 The annual Night of Lights in Vienkoči Park of Līgatne. 2018. (Photo by Rihards Vidzickis)

In the Forest of Light, which is the highlight of the annual Night of Lights, warm light and silence reigned after 6 pm regardless of the number of visitors. Ancient dances began with the lighting of lights. Later, there was a traditional procession of torches along the paths of the park, forming a seemingly endless snake of fire (*Fig. 32*). A show of fire jugglers was at the end of the torchlight procession. Vienkoči Park hosted the annual Night of Ancient Lights also on 1 October 2022. The main goal remained the same from year to year – to make one short autumn day longer and to charge oneself with candlelight for the dark period of winter. Candles were lit in the Light Forest of Vienkoči Park, and various activities and the lighting of a barrel-shaped fire sculpture took place at the same time. In the traditional torch procession along the winding paths of Vienkoči Park, a fire snake was formed. The torchlight procession ended with a show of fire jugglers, involving the association Soul of Flames, Afroplus, flautist Ieva Rūtentāle and fire sculptures made by Kārlis Īle. On the evening of the Night of Lights, the most resilient and magic-loving visitors took part in the fire

ritual together with the folklore group 'Delve'. Here by the Līgatne River, everyone can find inspiration for cultivating a green lifestyle.

The festival of light *Staro Rīga* had grown over many years and gained international recognition among light artists, locals and tourists. One of the most colourful events *Staro Rīga 2017* took place from 17 to 20 November and marked a path of light to the centenary of the State of Latvia. In the Botanical Garden of the University of Latvia, people could see materialised images from earlier times in the 'Moonlight Greenhouse' light and video installation. Claude Debussy's 'Moonlight' led one to Carl Gustav Jung's theories of the subconscious in Ieva Balode's video work 'Dreaming Vol II', which linked symbolically with the environment. The environmental object of curved wire treated with luminescent paint in 'Arrivals' was subtitled 'They were here'. This installation made the departed visible as they came to life as ghosts in ultraviolet light. Artist Alexander Reichstein, who was born in 1957 in Moscow and has lived and worked in Helsinki since 1990, is convinced that people never disappear without a trace: we can still hear their words, footsteps, and even their breath. People who have been in the sun for a long time roam the garden, meet each other and enjoy nature. In Vērmanes Garden, the environmental art three-dimensional installation 'Symbiosis' showed the interaction of three dimensions of time, namely the past, present, and future. Serge Schoemaker Architects from the Netherlands created the architectonic light installation 'Allée of Light' (*Fig. 33*) to make people aware that we live in a world wherein there will always be two

sides: one warm and the other cold, one good and one evil, and one full of light and love and the other dark. These two sides create an eternal flow that influences our lives. One's only choice is to observe this flow or even experience the transition from darkness into light and to invite and bring others with us to witness it. We create all that we see around us ourselves and everything is possible. The light forever changes; sometimes it seems that it will disappear immediately, but it inevitably returns even brighter and larger. With the bright and all-encompassing light of the 'Alleé of Light', we want to congratulate Latvia on its birthday and believe that darkness will disappear once and there will be light and love on the way to Latvia and our stars. Even when one is seeming in a strait or narrow tunnel, there can still be light and it is in our power to see it and follow it.

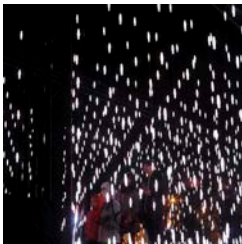


Fig. 33 The architectonic light installation 'Alleé of Light' in Vērmāne Garden. 2017. (<https://staroriga.lv/ru/4-gaismas-aleja/>)

In Kronvald's Park, which forms part of the City Canal greenery [2], a light installation titled 'Bwindi Light Masks' by Richi Ferrero, consisting of 40 light masks from the African interior and traditional music from the Tuva tribe from Italia featured an interesting light story. A total of 40 identical masks from the Bwindi Impenetrable National Park, at

the innermost heart of Africa, were arranged like small monoliths, thereby resembling ancient terracotta finds at an archaeological site. The rite came alive when artificial light altered the hues of the masks, creating a still dance supported by the bi-vocal sounds of the Tuva people of Central Asia. This dance painted a picture with shadows. Various companies, institutions, and private entrepreneurs took part in the festival participants' well-known programme 'Rīga Carnival' to illuminate the urban environment.

One of the most colourful events of Proclamation Day of the Republic of Latvia was the 12th *Staro Rīga 2019*, which featured a wide variety of light art objects and took place from 15 to 18 November. Its artistic concept entailed the four dimensions of the art of light—time, space, man and light—interpreted by artists from Latvia, Estonia, Denmark, Germany, France, and Great Britain according to their own creative intentions. The most pronounced artistic tendencies included laser projections and interactivity, which had more in common with generative art. Buildings, squares, bridges, and monuments were turned into unique pieces of light art. Kronvald's Park featured the sculptural light performance 'Lead Lights', which was composed of an impulsive interplay between people and light objects. Participants interacted with the installation to play with moving open-work projections and the surrounding environment, transforming the park space into a unified light game installation. The extraordinary road 'You, in me – I, in you' at Kronvald's Park to Ķerģalvis Pergola was created by the students at the Latvian College of Culture

at the Latvian Academy of Culture. Images of the 15-minute mixed-media symphony 'Sea Routes' by international artist group Tura Ya Moya (specialised in creating interdisciplinary analogue installations) were projected from sea containers that had travelled 3000 kilometres past Greenland and Scandinavia. An impressive multimedia performance with a water screen, 'Déjà Vu', created by Juris Matuzellis (Pepe), DJ Monsta, and other local artists on the City Canal next to Bastejkalns, aroused great public interest. A variety of technological aspects, audiovisual show elements, animation, holograms, water effects, motion and video graphics, fountain choreography, musical accompaniment, lights, and lasers were used in this visual game on a surface of the canal. There was a beautiful visual interplay with the canal water, which was raised to a height of 18 metres and 30 metres wide.

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The Construction

(Artworks)

Topic: Art, Architecture, multimedia

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Abstract

The exhibition of artworks consists of a poster and a multimedia part. The poster part shows the conceptual, contemporary single-family residential architecture. The project examines the existing space in an analytical and generative way. The main idea of the project is the structural and formal relationship of the building in the rural landscape with a strong reference to the natural landscape.

The project is an incredibly photogenic study in concrete and timber textures and

form, containing subtle nods to the kinds of architectural references. The project attempts to actively dismantle the object qualities of the architecture in favor of ambiguous, landscape-driven spaces of discovery and inhabitation.

The form of the building and its artistic potential is the result of the analysis and conceptual assumptions. It is from the ideological program and the features of the environment that a spatial layout is created, which is then subjected to the processes of architecture designing with the use of the generative methodology. The process of shaping the graphic and solid quality of architecture takes place with the participation of landscape, observation of sun movements, properties of plant forms occurring in the river valley adjacent to the plot, "framing" the most interesting naturalistic places, even integrating existing trees into the shape of the building. The exhibition aims to present the art of architecture in line with the idea of generative art. The exhibition consists of technical drawings of the designed building, graphics, and its rules of process, visualizations of the

architectural form, and the context of space. The graphic part is complemented by a multimedia part that presents the spirit of the context of space, design processes, and, finally, an artistic variation on the various stages of construction. The value of multimedia performance is a mutual interpenetration of virtual images and drawings of architecture with a real construction project extended over time. The building is still under construction.



Individual-based Epidemic Simulator and Its Visualization as Generative Art

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Abstract

The author developed an individual-based epidemic simulator in the spring of 2020 mainly targeting COVID-19. It is useful not only as a tool to help governmental decision making for both people's health and social activities, but also as an artwork to express fragility of human societies and individual lives. As the spread dynamics of infectious disease is a type of generative process, it would be possible to recognize the visualization showing the events in the simulator's virtual world to be viewed as a kind of generative art.

1. Introduction

Since late of 2019, infection of new Corona virus, SARS-CoV-2, has spread around the world with deadly disease, COVID-19. Facing those facts of the long incubation period and the easy spread by

airborne, many of the experts tried to contribute any points to avoid tragic damage on individual health and social activities. The author also started his own experimental project in March 2020, to develop a simulator under expectation to provide a tool for both education and prediction. Among the possible variations of modelling methods, the simulator is based on a multi-agent model but not on differential equations with continuous parameters.

One of the well-known methods for generative art is to use a model of collective behaviour of animals, such as birds, fish, and insects. The author's past experiences to create several artworks utilizing such models [1-5] were very helpful for development of the individual-based simulator. The basic model employed BOIDS algorithm [6] for collective behaviour for local contacts with probabilistic events of gatherings. It also models a long distance move within the simulated area. The rest of this paper describes a very short summary of the simulation mechanism, visualization, typical scenario, and then remarks from a viewpoint of generative art.

2. Simulation Mechanism

The model includes a lot of features that we assume to take important roles of the aspect of infection spread, such as, peo-

ple's behavior under restriction of transport and gatherings, pathogenesis from infection to recovery or death, development of medicines and vaccines, schedule of vaccination, appearance of new virus variants, and so on. This simulator has been used as one of challenges for scenario analysis to assist the decision making by national and local government in Japan, together with the other types of models of differential equations, machine learning, human network models, and so on [7].

The population in the virtual world is placed in 2D square plane where each individual moves around and contacts each other. The model of pathogenesis is applied to each individual when it is infected from the other via contact. The virus infects from one to another probabilistically when they meet each other in a short distance. The probability depends on the distance, the type of virus variant, immunity of susceptible individual, and so on. The test is conducted for an individual who has a symptom. When the test result is positive, the patient moves to the hospital as quarantine. The tests are also applied for those who have close contacts with the patient. After the patient is recovered, it returns to the home position. If the recovery was too late, the patient moves to the cemetery.

The simulation process runs along a scenario given in request for invasion of a new variant, vaccination schedule, restriction of travels and gatherings, obedience by people, and so on. It is useful for both inspection of the past and prediction for the future to evaluate the strategies.

It is possible to handle some millions of individuals as a population utilizing a parallel algorithm if the hardware has

enough capacity, but sixteen thousand is an appropriate number for smooth animation by an ordinary personal computer, MacBook Pro M2 for example. More details from scientific and technical viewpoint are described in the author's other literatures [8,9].

3. Visualization

An important feature of individual-based simulation is that it is relatively easy to make a graphical visualization to show what occurs in the virtual world in a micro level movement of individuals, which is helpful to understand the nature of spread dynamics. The population is shown as a distribution of dots on the screen that move for gatherings and travel. The time evolutions and the histograms of sampled indexes are also displayed dynamically. Figure 1 is an example display on the screen of full HD 1920x1080 resolution; that contains four charts and two histograms of statistics in the left side, and the population distribution in the rest part.

3.1 Population

Each individual is drawn as a small dot with the color that indicates the health state; susceptible, asymptomatic, symptomatic, recovered, and vaccinated. The population is animated as it moves. A thin triangle is attached when it travels in distance, moves to and from the hospital, and is buried in cemetery. These features enable the viewers to notify how spread happens when people have close contacts in gatherings. It is also clearly recognizable how travel makes the spread widely.

3.2 Trends

Some of the indexes measured in the real world on epidemic are useful to catch the current situation and trend as several governmental organizations for health and private companies servicing big data have been providing those data online. In addition to these observable data, hidden indexes, such as the number of infected patients missing the tests are also measured in the simulated world.

In the left side of the screen shown in Figure 1 includes the ratio of the number of people of each health state, the number of asymptomatic and symptomatic patients newly reported per day, the number of patients for each rank of severity, and the number of patients infected by each virus variant. The scales of both horizontal and vertical axes are dynamically adjusted as the simulation process progresses.

3.3 Histograms

Some of the statistical frequency distributions are also helpful to understand the characteristics of current spread, such as incubation period, recovery period, period to death, and the number of patients infected by a single contagious person. The left bottom area shown in Figure 1 displays the histograms of these indexes.

4. Scenario

The setting of scenario depends on the objective of simulation. For providing an appropriate hint for the real strategy taken by the government, it should be realistic and includes possible alternatives on both future strategies and the new variant's unknown features. On the other hand, as an artwork, it would be better to be suitable to inspire the viewers a mixture of their past experiences and possible future events. Figure 1 is one of typi-

cal display on the screen after two waves passed using following scenario in JSON format:

```
{{"Lockdown", "symptomatic > 1000"},
{"gatheringFrequency", 10.0},
{"Lifting", "symptomatic < 600"},
{"gatheringFrequency", 50.0},
{"New variant", "days > 120"},
{10, 0, "X"},
{"Vaccination", "days > 140"},
{"vaccinePerformRate", 7.0},
{"Lockdown", "symptomatic > 1000"},
{"gatheringFrequency", 10.0},
{"Lifting", "symptomatic < 600"},
{"gatheringFrequency", 50.0}}
```

This scenario means as follows. When the reported number of symptomatic patients reaches more than 1,000, then the frequency of gatherings is set to 10% as a governmental countermeasure. If the number of symptomatic patients becomes less than 600, the frequency of gatherings is set to 50% as the restriction was lifted. When 120 days passed, a new virus variant named X invades and ten people get infected. From 140th day, vaccination starts by 0.7% subjects in the population per day. The second wave of spread happens because the characteristics of variants are as follows.

```
{{variant name:"Original",
reproductivity:1.0,
immunity efficacy:{1.0, 0.5}},
{variant name:"X",
reproductivity:1.5,
immunity efficacy:{0.5, 1.0}}}
```

This means the variant X has infectiousness 1.5 times stronger than the original one. The efficacy of immunity by infection is 100% for the same variant, but 50% for different one.

The protocol and efficacy of vaccine are also given by the following settings.

```
{{vaccine name:"PFBNT",
interval on:true,
```

```
interval days:21.0,  
vaccine efficacy:{1.0, 0.8}}
```

This specifies that vaccine named “PfBNT” requires second dose by three weeks of interval. The efficacy against the original variant is 100% but 80% against the new variant X.

Due to the acquired immunity by enough rate of population, the epidemic in the virtual world ends by no patients remaining in the population. For an exhibition setting, the virtual world is reset when the epidemic ends and then a new simulation process starts again. In the initial state of the simulation shown in Figure 1, the population size is 16,000 and 16 people are infected by the original variant.

This scenario was inspired from the phenomena happened from February to September 2021 in Japan. Effective vaccines were just released but the vaccination was not conducted widely yet. Alpha variant invaded to Osaka area and soon it spread rapidly around all other areas. As a response to the severe shortage of medical resources, the government applied a strong restriction on people’s activities for both travels and gatherings. The spread gradually shrank as both people’s obedience and vaccination. Once it looked hopeful as if the epidemic would end, but Delta variant invaded and some patients suffered severe symptom, typically those who were not vaccinated yet. As the cumulative rate of vaccination reached more than 70%, the spread got rapidly shrunk, and the social activities recovered until Omicron variant comes.

5. Remarks

Spread of infectious disease is a type of complex phenomenon as it includes a generative process. Animated visualization is helpful not only for researchers but

also for ordinary citizens and political decision makers. At the same time, such type of visualization has a potential as a type of artwork to provide an occasion for viewers to consider the fragility of human lives and our society.

From a viewpoint of aesthetics, a fine scale of complex movement of massive collection of particles together with dynamic transition of whole visuals is one of the popular techniques to attract human eyes. The animation shown as the population moves includes such feature.

As future works, sonification of visual animation [1,3,5] and speech of narratives on the events in the virtual world [2,4] will be helpful to make this work more impressive for viewers.

The author hopes this work would provide occasions to people both to learn how the countermeasures work and to consider what was the pandemic for both individual and society. The project information is available from the following URL:

<http://www.intlab.soka.ac.jp/~unemi/SimEpidemic1/info/>

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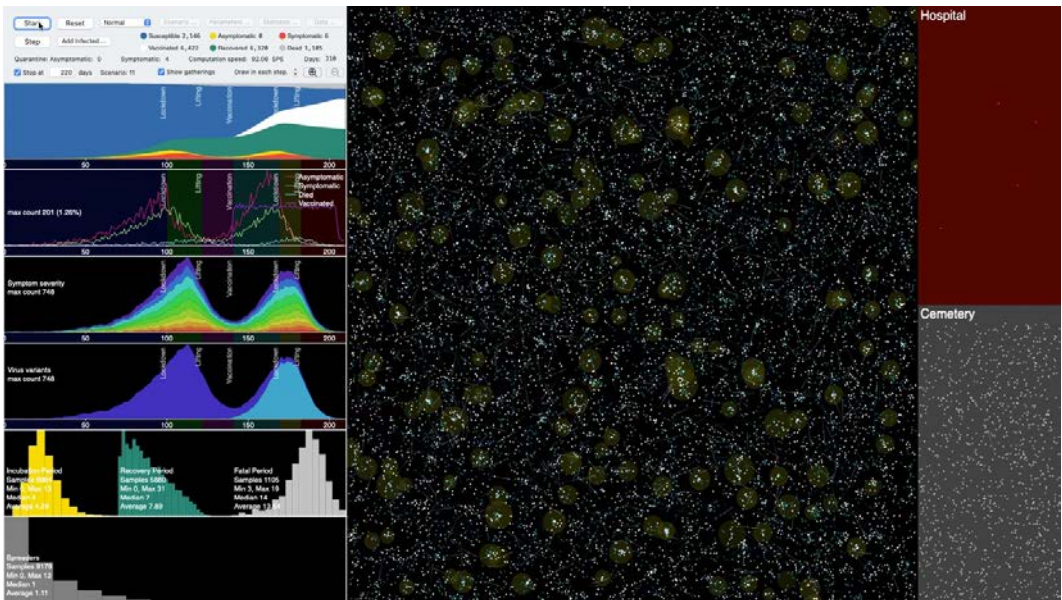


Figure 1. An example display on a full HD screen.

Full duration of video is available

in <http://www.intlab.soka.ac.jp/~unemi/SimEpidemic1/movies/SimEpiE001.mov>

MoliAlre, a theatrical agent which speaks like Molière's characters

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Abstract

This project introduces an artistic dimension to automatic conversational agents through the implementation of MoliAlre, a theatrical agent based on a generative language model which gives replicas like Molière's characters. A first version, used as a baseline, shows the artistic potential of the model. We describe the results by exploring two directions that significantly improve the performances of the model. On the first one we train the model on several authors having a similar style to Molière to improve the performances. On the second one, a reverse generation method favours the generation of rhymes. Every model presented in this paper is available online for testing:

<https://www.lamsade.dauphine.fr/molierelebot>

1. Introduction

Art, like many other fields, is not escaping the growing wave of Artificial Intelligence (AI). The automatic generation of images, texts or music are challenges that guide the research of the AI scientific community and push researchers to develop innovative

algorithms. More and more these algorithms become accessible and are now used in many artistic projects.

This project aims to be part of this dynamic by introducing a Conversational Agent (CA) which 'speaks' in the style of Molière's characters, freely accessible by everyone. Beyond the entertainment aspect, this project is the opportunity to introduce CAs in the field of theatre, where we observe a real scarcity on theatrical and literature applications.

2. State of the art

CAs are dialogue systems that can hold an open-domain conversation without specific structure.

Since the introduction of the Transformer architecture [1] and the success of generative language models like GPT-3 [2], most state-of-the-art CAs are based on an end-to-end decoder-only Transformer neural network. They consist of several billions of parameters and are trained to recreate conversations collected on the web. With Meena [3], Google Research showed that a large end-to-end neural model can display more human-like attributes while being simpler than hand-crafted frameworks.

FAIR went a step further with *BlenderBot* [4] by showing that large improvements can be made by fine-tuning on data that emphasizes desirable conversational skills (personality, knowledge, empathy). One of the latest state-of-the-art open-domain CA is *LaMDA* [5], a Transformer-based neural language model with 137B parameters and access to external APIs (information retrieval system, translator, calculator).

3. Baseline model, *MoliAlre*

Following the state of the art, *MoliAlre* is based on a generative language model, pre-trained on a large French text corpus [6], providing it with basic knowledge on French grammar and word meanings. Its weights are then fine-tuned on a corpus of texts, built from Molière's works, each element of which is a dialogue extract of the form:

USER: line 1
MoliAlre: line 2
USER: line 3
MoliAlre: line 4
 ...

Once trained, the model can be used as a CA as follows:

- the user enters a cue. a context identical to the one used for training is created but leaving *MoliAlre*'s cue empty.
- the context is sent as input to the model which completes the cue of *MoliAlre* and stops when a special token representing the end of cue is sampled.
- the process is repeated to generate a conversation by accumulating the exchanges between the user and *MoliAlre*.

Raw data The raw data consists of 32 plays written by Molière, for a total of 15 283 cues.

Making dialogue extracts For each line, a dialogue extract between the user and *MoliAlre* is created by adding subsequent lines from the same scene until the scene is completed or the length of the extract exceeds the maximum length allowed by the model. It is important to make sure that each extract created contains at most two different characters to match the case of a discussion between the user and the model. If it contains more than two characters, it is divided into several sub-extracts containing only two characters. Around 20% of the extracts are removed from the training set to build the validation set.

Pre-trained model We use *GPT-fr*, a *GPT-2*-like model trained on a french corpus with 1 billion parameters, 24 decoder layers, 14 attention heads per layer and a 1792-dimensional embedding.

Training The model is loaded and trained using the Hugging Face python library, on an A6000 GPU with 48Go VRAM. The learning objective is to reconstruct the dialogue extracts by minimizing the logarithm of the perplexity. Each dialogue extract is divided into a sequence of tokens $U = \{u_1, \dots, u_n\}$ and the model parameters θ are optimized by minimizing:

$$\mathcal{L}(U, \theta) = - \sum_{i=1}^n \log P(u_i | u_1, \dots, u_{i-1}, \theta)$$

Inference To favour diversity in the

model responses and improvisational effect, we use a stochastic generation strategy. We choose *top-k sampling* method for generation. According to the context prompt, the model generates the probability over every token to be the next token. We sample the next token among the k most likely. We use $k = 40$.

Evaluation The model has a perplexity of 14.88 on the validation set. We introduce a method to use the BLEU score as a style evaluation. BLEU score is an automatic metric that outputs a number between 0 and 100 by comparing candidate texts with reference texts. In practice, the concept of reference text is not easy to define in a theatrical improvisation. The evaluation method tested is the following:

- generate n candidate cues with no initial context input to the model to simulate a free cue generation of *MoliAlre*.
- for each generated cue, use the set of original cues from Molière's 32 works as reference text.
- compute the BLEU score between candidates and references.

We found this method to be highly dependent on the generation method and the number n of candidate cues. We ran 5 iterations using *top-k* with $k = 40$ and $n = 1000$. Results are reported table 1.

Iter. 1	Iter. 2	Iter. 3	Iter. 4	Iter. 5	Mean
30.54	37.99	31.95	29.74	22.92	30.63

Table 1 : BLEU score computed for MoliAlre with top-k=40 and n=1000 for 5 iterations.

Given the same input prompt, the model

can generate a wide range of cues. It demonstrates a good ability to improvise.

The model doesn't overfit to the training data. Most of the cues it generates can't be found in the original Molière texts. When prompted with an original extract of a scene, the model answers with new lines compared to the rest of the original scene. When prompted with modern French, the model does not change its response style and remains in a style close to that of Molière. The main weakness of the model is its coherence. It is not uncommon for the model to contradict or be inconsistent with the cues entered, especially if the subject evoked is far from the topics addressed by Molière.

4. Directions for improvement

4.1 Multi-author model

In the translation field, a trend in results is that multilingual models can perform better in per-language tasks than their equivalent monolingual model [7].

We studied whether training *MoliAlre* with multiple dramatists improves the performance of the model to generate cues in the style of Molière. We add 502 plays written in the 17th century to the 32 written by Molière, for a total of 189 905 lines. The creation of the dialogue extracts is the same as for *MoliAlre*. The new model, *MoliAlre-2*, is trained in two steps. First, it is trained on the 534 plays set, using a lower learning rate, as a second pre-training task to the generative model. Second, it is trained on the 32 Molière plays set in the same way as *MoliAlre*.

MoliAlre-2 reaches a perplexity of 11.52 on the test set, as *MoliAlre* reaches a

perplexity of 14.88 on the same test set. We ran the same BLEU score evaluation and results are reported table 2.

Iter. 1	Iter. 2	Iter. 3	Iter. 4	Iter. 5	Mean
31.02	30.74	48.60	35.49	31.95	35.56

Table 2 : BLEU score computed for MoliAlre-2 with top-k=40 and n=1000 for 5 iterations.

While the multi-author model achieves a better BLEU score on average, the score fluctuates a lot between each iteration. It is not trivial to conclude that it is better at predicting and generating cues in the style of Molière than the mono-author model. However, the additional training improves the model coherence, because it has seen more examples of conversations, while preserving Molière style.

4.2 Improving rhymes

MoliAlre and *MoliAlre-2* are based on a generative language model that generates text in an autoregressive manner. It makes it difficult to generate rhymes, as the rhyming words are found at the end of the lines.

To improve rhyme generation, we explore reverse language modeling [8]. The main idea is to generate every line in a reverse order, thus sampling the rhyming word at the beginning of the generation of the lines removing constraints of the already generated text.

A new model, *MoliAlre-VERSE*, is trained in the same way as the multi-author model (17th century corpus then only Molière). We filtered the data to train the

model on cues in verse only. The difference is in the tokenization process: we reverse the

token sequence of every line, but keep the line order for every dialogue extract, as shown in table 3.

Once trained, the model outputs encouraging results. When the input text is an alexandrine line with rhymes, the model has no trouble generating rhymes thanks to the reversed generation. Moreover, the model seems to have more facility in generating alexandrines, although this is not yet automatic. The rhymes are generally satisfactory, but it happens that the model generates rhymes by using the same word twice.

As the model is trained with verse-only cues, when prompting it with prose cues, it shows more difficulty in generating rhymes.

5. Conclusion

We introduced conversational agents in the field of theatre. We explored two directions that could help improve future related works.

The multi-author model seems to improve the generation in a specific desired style, but a more robust evaluation needs to be conducted to draw real conclusions. A human-based evaluation may be more appropriate to evaluate the performance of the model to mimic Molière's writing style.

The reverse language modelling model shows good performance for rhyme generation. It is an effective and simple method to generate rhymes without the assistance of any external information. Future works could focus on the capacity of such a model to handle both verse and

»

Original cue								
Parbleu,	je	ne	vois	pas,	lorsque	je	m'	examine
1	2	3	4	5	6	7	8	9
Où	prendre	aucun	sujet	d'	avoir	l'	Âme	chagrine
10	11	12	13	14	15	16	17	18
Inverted cue								
examine	m'	je	lorsque	pas,	vois	ne	je	Parbleu,
9	8	7	6	5	4	3	2	1
chagrine	Âme	l'	avoir	d'	sujet	aucun	prendre	Où
18	17	16	15	14	13	12	11	10

prose cues.

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Table 3 : Verse inversion method used for MoliAIRE-RIME training. Tokens of each verse are inverted but the order of the verses is kept.

Programming Complex 3D Meshes. A Generative Approach Based on Shape Grammars

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Abstract

This article summarizes the results of art based research developed thanks to a grant of the PUCP University of Lima in 2021-2022. It will be described an open source generative solution, based on generative grammars to create very complex and programmable 3D meshes. Analyzing hundreds of models generated with these algorithms, it was found a solution based on the idea of “intelligent meshes”, which change their behavior during the modeling process. This is done using tags, or vertices identifiers, that, like genes, describe the topological characteristics of each vertex and its generative development during the process. Tags can be programmed interactively editing its data with tools provided by the interface or using

generative grammars that allow an incredible variety of complex forms and stimulate the user creativity. The research findings also elucidate some important conceptual issues, like the importance of original technology development to defend cultural identity.

1. Introduction

Creativity is a key issue in arts, science and cultural industries, not to mention that it is of the greatest concern for innovative educational programs. But creativity is a difficult topic to be handled properly. It is enough to mention just three problems: creativity is hard to define, explain and measure [1], its aesthetic meaning and aura are jeopardized by postmodern art [2], over production and media saturation, and, last but not least, the disruptive effect of digital media.

To enter directly into the digital matter, today computational creativity, 3D modelling, animation and image processing technologies research, such as generative algorithms or fractals, is occupied by the AI and Machine Learning discourse. But AI, not so much paradoxically, leaves small room to users' creativity (Colton 2008) and, spreading Anglo-Saxon computational

thinking, is one of the most efficient assets of digital colonization [4]. These are good reasons to develop shape grammars [5] and generative algorithms as a valid alternative [6], for their simplicity, creative power [7][8] and because they offer the possibility to simulate natural phenomena and local artistic traditions, like ethno computation [9][10], intuitively and without black boxes [11][3]. In this paper I will concentrate the attention on software development, visual analysis and artistic practice results. Due to these properties, the generative design tools described in the following paragraphs will be valuable to artists, industrial designers and educators to experiment with new design processes, explore computational creativity as a research or educational tools and to link parametric design with cultural identity. From the production point of view, these algorithms help artists and designers to explore the relationships between forms and new materials also suitable for 3D printers and robotic fabrication.

2. Methodology

This paper is the result of an interdisciplinary artistic research project supported by a grant of the PUCP University of Lima. The research methods expand the art based research framework [12] and consist of: a) Review of papers in the field of Computer Science, Digital Humanities and Digital Art, especially generative design, shape grammars and ethno computation topics; b) Analysis of software for audio-visual creative production (DAWs and 3D Modelling software Rhino and 3D Max); c) Visual analysis of pre-Columbian art;

d) Software development using extreme and incremental programming; e) Artistic practice and digital fabrication with 3D printers and a Kuka robotic arm.

3. Results

3.1 Literature and Software Analysis

Papers about computational creativity, generative art and parametric design show that the potential of shape grammars is not fully developed [13]. Besides, there is a lack of friendly and interactive generative applications. On the other hand, plug ins (like EuroRack), programming languages (like Processing), game design engines or DAWs (like Unity or Reaper) that use AI or generative techniques can be often installed freely, quite often share the same algorithms and lack proper documentation. This is reflected in repetitive and standardized design artefacts.

3.2 Analysis of Natural Forms, Pre-Columbian Art and Shape Grammars Simulations

The capability and potential of L-Systems to simulate natural phenomena is well known [7], so it is not necessary to enter into this topic here. On the other hand, Pre-Columbian and traditional ethnic art shows [14] that algorithmic and natural procedures were commonplace.

As shown in figure 1, there is obviously a computational thinking in the ropes, knots and colours and a creative hypothesis to use them as a linguistic code or interface design metaphor to improve usability in shape grammars applications.

self-similarity, natural processes, and traditional designs' ethno computation. After the generation with different functions and parameters of hundreds of models, were selected two solution that solved the task to create something new. The first is the mesh remix tool set that expands the standard morphing process with additions like masks, side chain modulation, genetic behaviours, shape grammars and cellular automata (fig. 4). The second that will be exposed in the following sections, is the programmable mesh technique.



Fig. 4. Left: three meshes (ancestors). Right: three remix modes of ancestors.

3.4 Generative Programmable Meshes

The algorithm that will be described here is based on the idea of a mesh that changes its geometric properties during the generation process. Like in cellular automata and finite state machines, the mesh' vertices act like cells whose values describe topological properties, transformation parameters and other behaviors. In this way the mesh grows like an organic natural process. This is done using "tags", or vertices identifiers, assigned to a pattern of vertices that can be programmed interactively or using L-Systems [6]. This allows for an incredible variety of complex forms, and stimulates the user to experiment freely.

In the first step the user creates a pattern of n points (usually a multiple of 8 to match symmetry and bytes) and

allocates their alphanumeric identifiers, the tags. This pattern generates a closed shape with 8 or 4 axis symmetry (fig. 5). Here is where shape grammars and L-Systems come into hand, to create interactively the patterns and change the tags during the process.

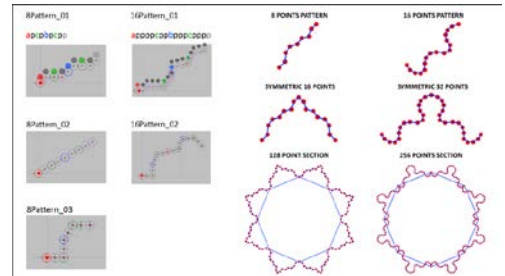


Fig. 5. Left: example of patterns. Left: construction of the mesh sections shape.

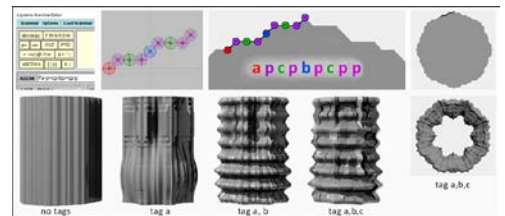


Fig. 6. Using tags in a programmable mesh. Top left: L-Systems grammar, tags pattern and the complete symmetric section shape. Down: adding tags transformations to the linear mesh.

Now, during the mesh construction, every point can be translated, scaled or rotated using their tag parameters, and behave independently or interacting with other tags, considering its XZ position in the section and in its height in the mesh (Fig. 6, 7). In this way every section or slice of the mesh can smoothly change its form without losing the formal coherence of the mesh as a whole. The interactions between points and tags can be done with cellular automata, interactive functions or reading values

from data sets or images. The tag rule set can be processed using the usual shape grammars substitution process embedded in the main function (Fig. 8). These data can be saved and combined with the others using the remix tools describe above.

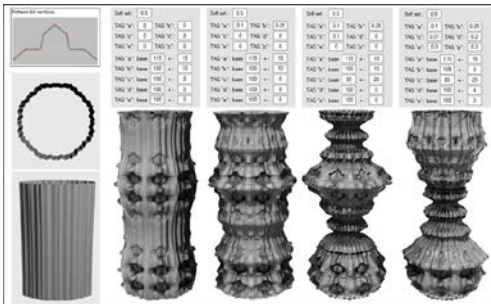


Fig. 7. Left: the pattern, the section and the linear mesh. Right: transforming the mesh with the same pattern and tags but different parameters' values.

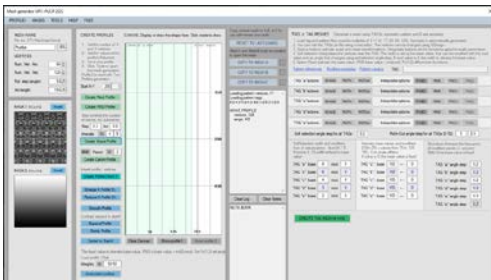


Fig. 8. The workflow is from right to left and from top to down. The right panel configuration depends on the previous choice of the user. The software checks which buttons are enabled, avoiding unnecessary work of the user. Help is included in the panel, improving the concept of the software as a book.

3.5 Technical Issues of Complex Generative Meshes

Generative processes like programmable meshes are highly unpredictable (this is the reason why they are so fascinating).

But this comes at the cost of geometrical problems that happens when vertices are heavily transformed and vertices' positions are too rough. In this sense, tags helps to analyze the topological data without performing tests that, when you are working with more than 1,000,000 polygons, slow down the process too much. The software additionally takes charge of other issues that could result in geometric inconsistencies such as face intersections that cause errors or the need to use support material in the 3D printing process.

3.6 Software Development and Interface Design. The Artist as Computer Scientist

Working with complexity, generative processes and art, it results that software development gets very confusing. It is interesting to stress here the different approach to programming of artists and computer scientists. In the present case, extreme and incremental programming paradigms were used, but when the programmers are artists, the development is a lot less linear than expected. While programming needs careful organization and a precise workflow, the artistic experimentation and software development needs improvisation, serendipity and permanent trial and error processes that leads quickly to bugs, undesired effects and ineffectiveness.

The solution was, in the first place, to experiment freely with the code at the beginning, and rewrite the entire application also improving the user interface design. Through parallel artistic production, it was found that the best software architecture should be modular, to help the user through the process step by step, with every step enabled by

its predecessor and the compatibility of geometric properties. The interface accompanies the workflow with instructions and examples on how to use every function, to make the learning curve as smooth as possible. Finally, considering the open source philosophy of this application, the code was revisited in the literary sense, and considered as a text in its full right.

4. Discussion

Setting apart the artistic and technical benefits, the research findings also elucidate some important concept issues about computational creativity and education.

4.1 Original Technology Research

In the first place, software development and artistic results exposed the importance of original technology research. This infers “reinventing the wheel”, in other words, to develop algorithms or functions are already available in internet. The true of this lies in the fact that real innovation comes from the deep understanding and control of every layer of the process; on the contrary, the use and abuse of libraries and ready to use solutions, that can be helpful to speed up production, generate creative constraints –the proper word should be cages- which creative results are not of the artist.

Original technology research is paramount also in the broader cultural domain, to defend cultural identity and correct the ideological biases [9] the commercial modelling solutions for artists, designers and architects. Every single line of code embeds significant knowledge that will unfold completely

when all the pieces are put together, giving to the software and to its users cultural definition and power.

4.2 The Black Box Problem and the Benefits of Generative Grammars Solutions

The computational and artistic research results demonstrate that complexity and creativity forms don't need complicated technological solutions; L-Systems, in this sense, have many benefits. First, with some improvements, offer control and flexibility almost like a programming language, but are easier to understand (yet certainly difficult to develop properly). In the second place, L-Systems grammars and codes are transparent, and more intelligible, compared, for instance, with AI algorithms [16] whose deep computational processes are puzzling even for their creators.

I will add that AI can be developed starting from the fundamental idea of meta-medium [17] and can be interpreted as interfaces architecture and design in any application. Also the difficulties of generative design can be limited with a proper interface design and coding style, both help the users to exploit the parameters' creative properties and the aesthetics properties of algorithms [18]. It is important to reckon that many independent and open source solutions are discarded because of lack of documentation.

4.3 Issues in Educational Technology

These topics are particularly relevant when digital tools are used in learning contexts [19]. Generative grammars lingo, like L-Systems, not only can be programmed easily, even without

experience, but also, very much like Turing machines, they can be developed by hand [21] and can be used as methods in analog processes with traditional materials. Even in digital processes, the need of computers appears only in the last step of the design process; in this way machines do not interfere with the development of a creative and critical computational thinking.

In this sense, cultural identity and ethno computation references and resources, like quipus or the yupana, are not just visual metaphors for interface layouts or artistic installations. Embedded and coded in algorithms and functions and supported by analogies in design methods, data structures and computations, cultural traditions come to life to shape contemporary culture as concrete methods, solutions and fabrication tools.

4.4 Conclusions

To finish, I will resume the main concepts and findings of the research, and some ideas about its future developments and improvements.



Fig. 9. Generative grammars and programmable meshes can simulate different artistic styles, and help to understand their formal processes.

a) Generative grammars proved, through artistic practice, that are very

creative tools and that there is no need of machines to foster digital literacy and computational thinking. Using traditional techniques and materials overcomes the techno centric bias that educational technology carry out [11].

b) Cultural traditions, native artistic practices and ethno computation are inherently modular and recursive, thus and can be molded with shape grammars and the tag solution discussed here smoothly (fig. 9).

c) Generative art and generative grammars are techniques with a great creative and heuristic potential, as software development demonstrated during the project activities. From the aesthetic and epistemological point of view, the artistic research validation can be sustained precisely by this heuristic potential, whose evidence is the artistic production and its diffusion in design communities.

d) Software development and artistic practice also discovered some geometric and topological problems raised by complex generative processes. But the programmable tag mesh solution minimizes this issues and facilitates the compatibility with digital fabrication and demonstrated that complex forms can improve competences in 3D printing and robotic manufacture and the possibilities of recycled organic materials (Fig. 10).



Fig. 10. Complex meshes to adjust 3D printing process

Setting apart technicalities, this computer interdisciplinary research also enlighten some interesting concepts about computational creativity and the relationships between computational creativity and education.

a) Writing our own functions and giving up the cut and paste of software libraries may seem excessive, since requires hard work and a sort of “rediscovering the wheel” process. But this is necessary for true digital literacy, technological innovations and creativity. In fact, the control over these pieces of knowledge (algorithms, processes and parameters), we eventually miss using libraries lightly, is the key to add aesthetic value and originality to our projects.

b) It should be paid a lot more attention to the cultural aspects of software and interface design. Software is a complex cultural object with many layers of meaning that still we are not taking advantage as such. For educational and artistic purposes of computational thinking and creativity, the artistic research enlightened the differences between coding and software. Software is more than writing code, includes interactivity, the coherence between ends and means, cultural biases, issues about the distribution of information of knowledge. So far, software as cultural object needs much more humanities than sciences.

4.5 Further development

Generative design methods like shape grammars and techniques like programmable meshes can be indefinitely developed and improved from

the computational, aesthetic and educational point of view. I will mention some lines of research in digital humanities that seem particularly important: to develop interface designs and human-machine interaction strategies for creative purposes; explore software as a text, in the sense defined by [20], that gathers technical and creative means, data, concepts and audiovisual resources; and finally, strategies and programs to improve the interdisciplinary formation of artists as inventors and scientists.

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INK-SIGHT, MY SIGHT

(paper)

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Abstract

We explore art making through infusion an ancient medium (ink wash painting) with a contemporary medium (artificial neural network). The process started with traditional ink wash painting of house plants. The manual efforts of 500 paintings were base dataset to “nourish” AI models. Through successive interactions the artist’s “my sight” with trained “ink-sight” models. The artist and AI models evolved. The INK-SIGHT, MY SIGHT exhibition presented the original paintings, AI generated paintings, and behind the scene computer programming. The installation hoped to raise concerns and promote discussions on ethical issues of AI generated artworks. We also reflect on the experience of working with AI.

1. Introduction

INK-SIGHT, MY SIGHT is a creation of traditional ink wash painting combined with machine learning. It presents traditional oriental painting in a new way by adding the creative theme of growth with new technology. And explores the issue of artificial intelligence, as well as conveys the issues that the creators want to express through the exhibition.

Ink wash painting is representative of traditional Chinese painting. The term imitation is used in ink wash painting to refer to the imitation of artists’ brush techniques and styles, rather than to aspire to the realism of objects. Ink wash painting reflects the world as seen by the artist and is expressed through the work [1, 2]. Artificial intelligence learns from the input data, and through regular data arrangement and programming parameters, the model can have different training modes, and the regular training can make the image generated by the model have good quality. The creation process of this work focuses on the action of learning by artificial intelligence. Each time the model completes its training, it generates images of each stage. We observe these images and record the changes in the model, and observe how the model learns data through the images of different stages.

Almost the way we interact with the AI is the creator's perspective and the creator's point of view and the ideas of the AI model are only given by the creator. INK-SIGHT, MY SIGHT is composed of three series of creations, and developments series 2 and 3 based on the series 1. Through different data input and numerical settings, we trained six Ink-Sight models.

2. The Process

To use machine learning in the art creation process, we envision, during each training process, there may be some parts that we specifically want to let the AI model learn and hope that images generated by the model will have more of these features. Through the above studies, we identified the Generative Adversarial Network (GAN; [3]) as the basic machine learning framework. In particular, the pix2pixHD implementation [4] was adopted to train our own digital ink wash painting machine.

The process started with traditional ink wash painting (original painting) of house plants. To contrast the progress of art works, we also recorded the growth of a house plant in time-laps videos. We have developed Ink-Sight in three series: Natural Growth Series, Shadow Series, and Spaciousness Series. In Natural Growth Series (Ink-Sight_N models), we train Ink-Sight with the original painting. We noticed, while working with the Ink-Sight_N models, learned outcomes (e.g., Figure 1) with appearance of shadow or silhouette, or with spatial quality. This led to further dataset preparations and the training of Shadow Series (Ink-Sight_S models) and Spaciousness Series (Ink-Sight_P models) painting machines.



Figure 1. An Ink-Sight painting

Natural Growth Series (Ink-Sight_N models) is trained with 500 original paintings and their respective photos of house plants. The dataset contains 1000 image files (500 image pairs). Under the learning rate 0.0004, we set the training times of 100 and 200, and resulted two Ink-Sight_N models (Ink-Sight_N100, and Ink-Sight_N200).

Shadow Series (Ink-Sight_S models) is based on the Ink-Sight_N200 model with additional dataset to achieve the goal. We selected six sets of shadow-prominent image data from Ink-Sight_N100 and Ink-Sight_N200 models. From these data, a 100-image dataset and a 300-image dataset were created through random sampling. Under the learning rate 0.0004 and epoch 100, we trained the Ink-Sight_N200 model with additional dataset separately and resulted two Ink-Sight_S models (Ink-Sight_S100 and Ink-Sight_S300).

Spaciousness Series (Ink-Sight_P models) is based on the Ink-Sight_N200 model with additional dataset to achieve the goal. We selected ten sets of space-prominent image data from Ink-

Sight_N200 model. From these data, a 100-image dataset and a 300-image dataset were created through random sampling. Under the learning rate 0.0004 and epoch 100, we trained the Ink-Sight_N200 model with additional dataset separately and resulted two Ink-Sight_P models (Ink-Sight_P100 and Ink-Sight_P300).

3. The Installation

The INK-SIGHT, MY SIGHT installation (Figure 2) contains four parts. Part one, creation records, exhibit all 500 original paintings. Part two, ink wash painting files, exhibit paintings generated by Ink-Sight models. Part three, behind the image, displays program source code and execution logs. Part four exhibits model vision.



Figure 2. INK-SIGHT, MY SIGHT exhibition

Visitors can watch the exhibition to understand the whole learning process of artificial intelligence, the records, and the message behind the exhibition. The exhibition starts with a “document exhibition” to explore the production of artificial intelligence models. Visitors can sit on seats in the middle and feel the whole atmosphere of the exhibition. The chair is not only a place for visitors to sit and feel but also to rest and discuss. The movement of the exhibition is specially

planned around the middle chair, which on the one hand symbolizes the relationship between the layers of artificial intelligence training and on the other hand indicates the sequential operation of the program.

The artificial intelligence model grows by learning input data through the algorithm of machine learning and then generates images after the training. We hope that the visitors can understand the training steps through the exhibition. It composes of two white walls and many boxes. The white walls mainly provides information and steps for the training of the artificial intelligence model, and the first wall describes the input label and input image of the model training (Figure 3, top).



Figure 3. Part I: creation records (top: derivation of Ink-Sight models; bottom: the original paintings)

The 500 pieces of original ink wash paintings are made on paper rolls linked

to the input image to simulate the data input and to visualize the model's learning of ink wash painting (Figure 3, bottom). The second wall represents the appearance of the six models after training (Figure 3, top). The square on the left indicates that the models will generate multiple models during training, and through the parameter setting of the computer, the models will be saved. The images will be generated by inputting the pictures into the computer, and finally, the concept of a tree diagram is used to represent the kinship between the six models. On the right side, the overlapping box is displaying the original ink wash painting and the video record of two plants on the table, which have been elements since I started to create. By recording the growth process of plants through cameras, we also metaphorically describe the process of co-evolution between plants and Ink-Sight models.

However, after watching the first part, these seemingly normal processes actually have a hidden problem--the content of the data directly affects the model's brain. That is, the model is only familiar with part of the data and cannot understand the whole, and the process of training artificial intelligence cannot be seen, nor can it fully understand its learning operation. In my series creation records, each series model will overwrite the previous content after a new training, and gradually turn to learn new data, and the characteristics of the generated image will be more similar to the new one. The second part, ink wash painting file, is a selection of the images generated by the six models. The records contain detailed training models and the process of generating images. 100 images are pasted on the wall in the form of photo frames so that viewers can see the details of the images and the

information (Figure 4). The original paintings allows the viewer to see the results of learning ink wash painting by artificial intelligence, and also echoes the previous part.



Figure 4. Part II: ink wash painting files

Recording the image generation of each step of the model training looks like several paintings hung on the wall and several photo frames from afar. This arrangement actually has a special purpose: The artificial intelligence can also become an independent artist after training, so the production of the model can be regarded as a new creation. On the other hand, these images are all digital images, and this concept is the same as photography. The format of photography exhibitions is often presented in the form of exporting multiple photos and displaying them on the wall. This section of the exhibition is similar to a photographic exhibition, the viewer can feel like they are viewing a

painting as well as a digital image when watching the ink wash painting files.

The message of the second part is to reflect on the singularity of data in the training process of artificial intelligence with the image features produced by the model. And to link the third part: Under the Image. This work is composed of several long transparent celluloid strips with the training procedure printed on them. These transparent sheets of different heights and lengths flash and shake under the light. The invisible transparent sheets actually want to convey to the viewer that the training process should be open and transparent, including the input of data.

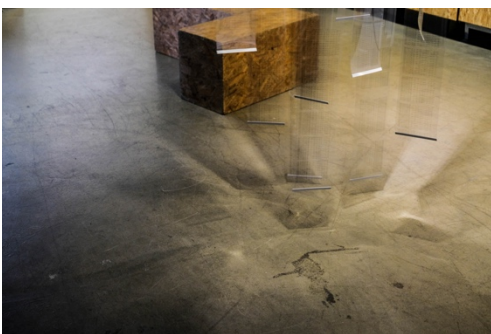
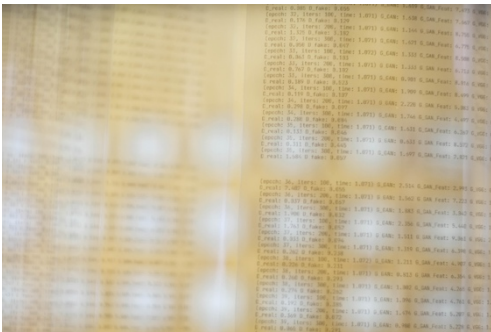


Figure 5. Part III: behind the image

Nowadays, there are many different artificial intelligence models with different parameters and computation methods. There is no related research or information on how to pursue the fairness

of the training data process. In addition, another purpose of using transparent film in the third part of the work is to allow the viewer to see the fourth part and the second part.

The last part of the exhibition is also the fourth part: Model Vision. This is a composition of images generated from the same image input to different models. The models crop and merge the same image to show how different the same image is in the eyes of each model, and also to show the model's expertise. The fourth part, seen through the third part, means that these images were created through the training program, in the same way, that the second part is seen through the third part.

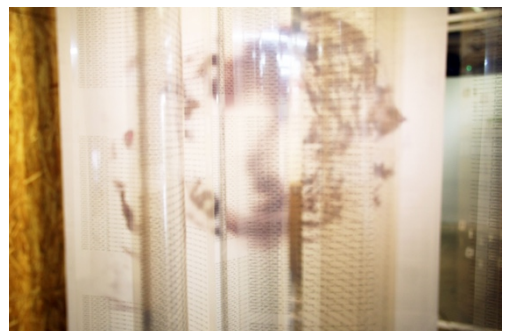
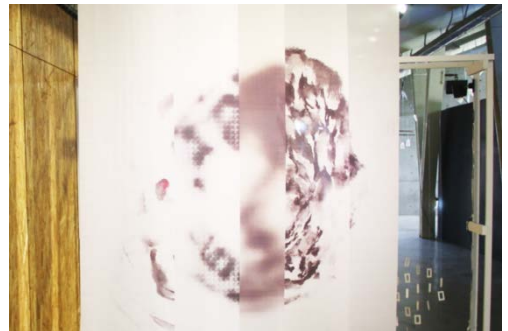


Figure 6. Part IV: model vision

4. Discussion and Reflection

Ink-Sight models are trained by human beings. Human beings inevitably have

personal preferences, therefore, models are bound to carry subjective thoughts of human trainers. Machine learning AI is bound to have more applications as the technology advances. The issues related to “fairness” and “transparency” of the datasets and algorithms are being emphasized and debated. Machine learning AI is developing rapidly. There are many pre-trained models and online platforms for image creation (e.g., DALL-E, Midjourney, Playform), allowing people without computing program backgrounds to experiment. As a result, artificial intelligence art creations are increasing. The controversies of who should be the creator of the artworks are gradually gaining attention. INK-SIGHT, MY SIGHT aims to make visitors aware of the hidden dangers brought about by emerging technologies through its creation and exhibition, and to reflect on the application of artificial intelligence to modern society.

Ink-Sight models are infusions of an ancient medium (ink wash painting) with a contemporary medium (artificial neural network). With an input photo, these models can generate outputs with expressions of ink wash painting. From the utility perspective, Ink-Sight models are style tools with specific personal flavors. However, computational ink wash painting style simulation tools have been developed by many researchers (e.g., [5-11]). Our models as art creation tools may be very dear to us but may not be suitable for other artists. In fact, we consider Ink-Sight models are beyond tools; they are mediums of art making. An Ink-Sight model enables the artist trainer to examine her ink wash painting from a different light. The artist's revelation, in turn, triggers new focus of expressions or affect dataset preparation of new Ink-Sight models. We have also

observed such kind of intensive interactions between AI artists and computing technologies they use (see: [12]). Could Ink-Sight models be collaborators of the artist? It is not the case in our experience of INK-SIGHT, MY SIGHT. Nevertheless, with the inspiration of the artist Harold Cohen and AARON [13], we are keeping an open mind on the possibility of artists collaborating with their personal machine learning AIs.

5. Acknowledgement

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Francesco Borromini drawing

LIVE PERFORMANCES

Albion – remix intermedia project

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Abstract

In a contemporary world defined by technological advances, combining different disciplines of the arts to reach the viewer through multiple channels of perception is becoming an increasingly common and interesting, emblematic phenomenon. Syncretic activities on the borderline of composition, improvisation, interpretation, sensory experience of the emerging work expand the areas of creative creation. The interdisciplinary approach deepens artistic awareness and encourages experimentation,

bringing together diverse artistic communities to shape a space for multidimensional collaboration.

The Albion project was inspired by British composer Thomas Adès' music. This audiovisual work is a collaboration between a music choreographer and a visual artist.

The premise of the Albion - remix project is an attempt to give a new quality to an earlier creation, in which the guiding idea was to 'hear and see' music through the prism of the virtual world. The means of expression sought were focused on creating a work in which the music and all its elements become a stimulus for movement interpretation, as well as all visual activities, creating an integrated polymedia artistic message. The project was realised outdoors, where the natural environment influenced the artistic decisions made - becoming one of the elements of the creative work. By projecting animations onto spatial objects, they were given new dimensions and/or brought to life. The resulting project was recorded and used to further explore both the music and the visual and movement layers. Using the previously recorded work, the focus was

on finding a kind of dialogue between what was recorded and the new idea. The resulting form of the image corresponds with the earlier recording, while deforming it through visual treatments to create a kind of artistic-cognitive hybrid. The live movement blends into the background of the projection through a kind of image manipulation resulting from the animation's reaction to the performer's movement. The course of the performer's movement is a planned composition with elements of improvisation resulting from the need to shape the image of the emerging projection. Each of the assumptions made was intended to show the dynamics of the creative process resulting in an interdisciplinary, generative aesthetic work.

Keywords: intermediality, Polish contemporary art and music, body movement, music choreography, virtual reality, generative music, electro-acoustic music.

Naturalness silence

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Abstract

Tra gli alberi, un silenzio/ Among the trees, a silence

*A volte tra gli alberi, un silenzio spazia/ Sometimes among the trees, a silence spaces
Come per incanto tra i vuoti delle foglie./ As if enchanted among the leaves emptiness:
Dilata la luce lentamente con forza. / It dilates slowly the light with force.*

Tu rimani attonito, ti senti estraneo.,/ You stand astonished, you feel extraneous...

*Una scena dove tutto è rappresentato unito. / A scene where everything is represented
united.*

*Ti senti nel luogo, ma non partecipi. / You feel yourself in the place, but you do not
participate.*

Quel silenzio lento ti avvolge il cuore. / That slow silence envelops your heart.

Lento come goccia che cerca una discesa e spaurita teme il vento/ Slow as a drop that

seeks a fall and terrified fears the wind

Per non cadere sola tra le pietre stanche/ Not to fall alone among the tired stones.

Silence is the language of all strong passions, in opposition to the word, an art created by men.

Silence is, like a work of nature, possessed of an extraordinary force. A force that can never be completed, unreachable by human abilities, deceived by nature itself, which gives the illusion of infinite silence.

A 'strong passion', as Leopardi calls it, cannot last for more than a defined moment, the time of a tremor, of a thought. Only the imagination can approach an idea of silence without reaching it, neither through the senses, nor by 'aiming' beyond Leopardi's 'hedge', that is our psyche.

This performance tries to express the naturalness silence connecting the generative interpretation by Celestino Soddu of the Baroc façade by Borromini in Piazza della Chiesa Nuova with an imagining natural space evocated by the tree in front of the façade.

This space generates poetic words by Enrica Colabella inside moments of silence and sounds from a wood at down.

Dancer Kathryn Ricketts will interpret architectural spaces and words generating silence with dance, performing with her body the complex connections between spaces, words and body by discovering the naturalness silence.

She will work with the images and text inspired by the concept of Inside moments of silence.

The dancer will be accompanied with moving projection of Borrominian architecture while improvising with the poetic text inspired from silence.

Ad Vitam, Expletus

An AI powered audio-visual, meditative journey into impermanence

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the whole ecosystem have been perfected in over 2 decades by Filippo Gregoretti.

The artwork develops a personality with each launch, giving rise to a fresh artificial entity. When an artwork is terminated, it evaporates and everything is lost.

Ad Vitam, an installation and performance based on Amrita: the artificial artistic intelligence for audio-visual impermanence

“Ad Vitam” is a living, impermanent artwork based on Amrita, Filippo Gregoretti’s artificial artistic intelligence algorithm. Ad Vitam produces an endless, unpredictable and non-repeatable stream of stunning visuals and music that brings the audience on a meditative journey into impermanence. It is part of a larger artistic framework which includes installations, NFTs, live performances and applications.

Amrita concept, as well as algorithms, real-time composition techniques, and

A·M·R·I·T·A
audiovisual impermanence
अमृत

Ad Vitam, impermanence within eternity.

Ad Vitam is an instance of the AI nourished by the powerful paintings depicting roman architecture by Daniela Bendoni, and by drawings, music, photographs, and artistic directives by Filippo Gregoretti.

Ancient monuments and transient artworks contrast each other, causing a dialogic short circuit that encourages a

connection with the innate sense of impermanence that exists in all of us.

The live performance, or “**Ad Vitam, expletus**”, consists in a musical duet with Ad Vitam, where Filippo Gregoretti plays the harmonium led by Amrita, which creates the main visuals and music. On a secondary screen Amrita instructs Filippo in real-time, guiding his performance on the instrument towards the correct rhythms, harmonies and atmospheres. A codified language between the artificial being and the performer can identify the harmonic and narrative direction both visuals and music are going towards, thus helping the human musician to improvise in the correct scales and within the intended emotional frame. The AI's distinctively evolved personality drives the performance.

Performing on an ancient sacred instrument of prayer, driven by the artificial artistic intelligence, on visuals and music that cannot be predicted, Filippo creates sessions of “trans-human yoga”, melting human and machine into a mystical, mantra-like, meditative experience.

Amrita is designed to create different, unpredictable visuals and music for 1000 years. The performance with Filippo though, usually lasts between 20 to 40 minutes.

The performance starts with Ad Vitam coming to life, warming up, and getting to know its surroundings (the hardware capabilities it is creating with, including network, webcam, and all input and output channels). On the secondary screen, the new personality in which

Amrita is born, tells the live musician which emotional frame it is compelled to start its living journey with.

The performance has several moments, all driven by the emotional and creative progress the artificial being is going through, up to the end, when the musician “kills” the artificial being, and the whole experience is blown away like a sand mandala...

Ad-Vitam App Artwork

The artwork has also been released as the first-ever “App Artwork” distributed on Apple and Google app stores. The app personality is designed to live only 20 minutes per day. Once the time is elapsed, the artwork passes away alongside all its creation.

Ad-Vitam, Expletus live performances require a projection screen, audio equipment, and a regular microphone to augment the Harmonium's sound.

Filippo Gregoretti

Filippo started coding generative projects for 8-bit computers at the age of 10 in the early 1980s, with polyphonic music expressed in hertz and milliseconds, and images created in hexadecimal data.

Following a formal education in visual arts and music, he worked as a traditional designer, visual artist, and musician while expressing his creative talents in a more technological form.

In the early 1990s, he founded “Alpha Channel,” Italy's first interactive media creative agency. During those years, he had been a pioneer in connecting the arts and technology in Italy and abroad.

In 1993 he founded “NeT-ArT”, one of

the first, if not the first, online integrated art projects.

In 1996, the jury of Mediartech, Florence's Multimedia Opera Festival, chaired by Gillo Pontecorvo, awarded him first place for the "Virtual Tour" project.

After that, he established ForteYang, an international award-winning creative interactive agency. While at ForteYang, he was able to present his transdisciplinary vision of authoring music, visuals, algorithms, and interactive experiences for clients in Europe, the United States, and Asia.

He also wrote music and performed all over Italy with the iconic band CONTROMANO in the 1990s and early 2000s.

He left the agency (and the band) in 2004 and relocated to China to pursue a solo artist and consultant career. He collaborated with creative agencies all over the world on his highly innovative interactive projects, and his musical works have been featured in films and the arts, as well as released by international record labels.

While developing algorithms to replicate human behavior for decision-making for the gaming industry, his interest in generative art increased. He developed the "Amrita" concept, algorithm, and technology over the past two decades, perfecting an artificial artistic intelligence capable of simulating human complexity in audio-visual creation. He was inspired by his work on artificial beings as well as by his experience as a pianist improviser and fine artist.

With Amrita, he performs on the harmonium both locally and

internationally. He also just released the first-ever "app artwork" that is available in app stores.

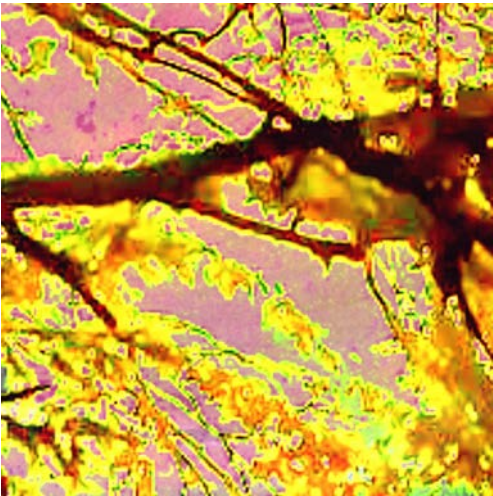
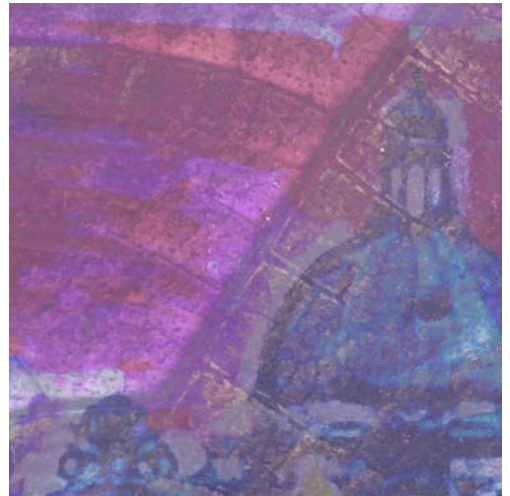
At Naples' Suor Orsola Benincasa University, he also takes great pleasure in teaching students a range of disciplines, from transdisciplinary creativity to digital experiences technology.

Daniela Bendoni

Born in 1942, Daniela studied Fine Arts at the Accademia di Belle Arti di Roma. During her long career, she worked as press agent and organizer for uncountable cultural events, related to arts, cinema, theatre and television. She displayed her artworks in several personal and collective exhibitions. She has been promoter for several prominent figures of Italian show business and culture. Amongst many, just a few of the events and organisations she worked with: Mostra internazionale del Nuovo Cinema di Pesaro, Sindacato Nazionale Critici Cinematografici, Settimana Internazionale della Critica at Festival del Cinema di Venezia, Fondo Pier Paolo Pasolini, RAi3, Teatro di Rebibbia Nuovo Complesso, etc. Since 1993 she is promoter and press agent for Maestro Nicola Piovani.

Images from Ad Vitam performance and installation.





Riding the audio wave

A7, a custom-generative software for visual performance

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1 Introduction

1.1 Presentation

This paper presents the philosophy and main features of A7, a custom software for real-time visual accompaniment of musical performances.

Made with TouchDesigner, this work includes three distinct parts: the program itself, the generative and audio-reactive modules that feed it, and the graphical user interface that allows interaction with both the program and the visuals. This interface is similar to a musical instrument, and the performance to an interpretation placed under the sign of improvisation.

The three parts of this work are closely linked, each one coming, over the course of iterations, to question the others. A7 is

therefore a work in progress, constantly rethought, refined and enriched.

1.2 VJing, live visuals & A/V performances

The practice we are developing here is close to what is commonly referred to as VJing, a term born from an analogy with DJing in the musical world, and which seems to have originated at the end of the 1970s in the PepperMint Lounge [1], a New York nightclub, before being popularized by MTV in the 1980s [2].

The Video Jockey would therefore be the visual equivalent of the Disc Jockey and his role would be to select, manipulate and mix live video sources of which he is not necessarily the author, most often with existing tools.

The VJ is thus above all associated with the world of clubbing, his performance being regarded as mainly decorative, like a simple update of the light shows and disco balls of the 1970s.

Like many performers today, we do not find ourselves in this definition. Indeed, our approach is based, on the one hand, on the exclusive use of visual elements programmed by us and generated in real time, and, on the other hand, on a home-made software, as much for the

audiovisual processing as for the graphic interface.

Beyond these technical aspects, our approach is also distinguished by the context in which it is deployed. We don't work in nightclubs with DJs, but with electronic musicians playing live their own compositions in a concert configuration, and just like them, we claim the singular nature of our creations and their full belonging to the artistic field.

To define our practice, we borrow the terminology proposed by Steve Gibson and al [3]. When the visual performance is not, or very little, prepared with the musician, we will use the term *Live visuals*. When the work presented is the result of a real collaboration with the musician, we will rather speak of *A/V performance*.

1.3 Jonathan Noé aka Coloscope

This presentation of A7 aims to inform the demonstration that will be made during this conference. This performance will include a concrete implementation of the tool: the creation of live visuals for the Strasbourg-based electronic musician Jonathan Noé. Under the name *Coloscope*, he proposes an electro-punk

“torn between the first transgressions of krautrock and the synth lines of John Carpenter's films [...] an entirely live and largely improvised electro set that reconnects with the DIY, precarious and minimalist approach of punk and underground medicine.” [4]

Jonathan Noé built his instrument entirely with Pure Data, both for sound synthesis and sequencing. The program is mainly based on FM synthesis and excludes the use of samples. During the live performance, it is executed on a Raspberry Pi model B nano c omputer equipped with a sound and MIDI card

Pisound, a strong technical constraint, chosen and claimed, which imposes sobriety in the use of resources and denotes an approach anchored in FLOSS and DIY.

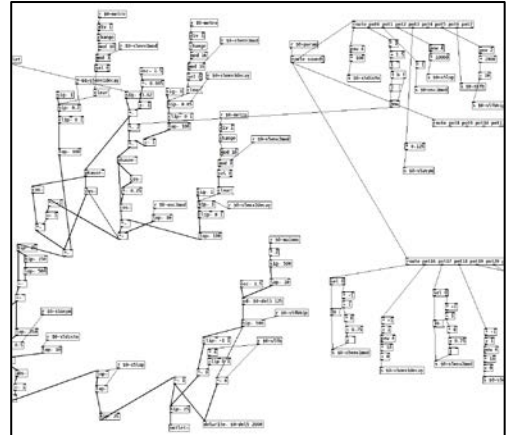


Fig.1 Screenshot of a small part of Jonathan Noé's Pure Data network.

In concert, the Raspberry works in an autonomous way, without a screen, nor mouse or keyboard. It is only driven by two MIDI controllers: a BCF 2000 control surface featuring faders, knobs and rotary encoders and a Nektar Impact LX25 two-octave keyboard equipped with knobs and rotary encoders.



Fig.2 Jonathan Noé playing while we are handling the visuals. ChaosLab 2, October 2022, Strasbourg.

1.4 TouchDesigner

A7 is designed with TouchDesigner [5], a visual programming language developed by the Canadian company Derivative. It allows the production of a wide variety of projects, from application prototyping to interactive or immersive installations, including audiovisual performance, virtual reality, mapping or concert light shows.

Similar to software such as Pure Data, vvvv or Max/MSP, TouchDesigner has the particular advantage of using Python as a scripting language, the software being delivered with a custom Python build.

Although the software is proprietary, TouchDesigner is offered in a free version for non-commercial use, with some limitations in functionality that nevertheless leave ample possibilities for creation.

2 Path, intentions and philosophy

The work undertaken with A7 follows on from various experiments carried out since 2017 in the field of Live visuals, with from the outset two parties that are still relevant today: the design and fabrication of a custom software, and the exclusive use of visuals generated in real time. The idea was to design a program, accessible through a user interface, allowing the manipulation of pre-written generative and audio-reactive visuals in real time.

Several versions followed one another. The previous one, which I used and refined for three years, was based on the use of a McMillen QuNeo MIDI controller which was not without programming and ergonomic issues.

It was this point that triggered the desire to completely redesign the program by replacing the MIDI controller with a touch screen, at the moment a Samsung Galaxy Tab A7 Lite tablet.

While the previous user interface was largely conditioned by the controls available on the QuNeo, the GUI accessible on the tablet is completely custom. It also removes a whole software layer: on-screen transfer of Quneo controls, MIDI feedback to the controller, LED lighting.

This choice implies radical changes, a simple update of the previous project was not possible. A7 was therefore created from scratch. However, thanks to the modular architecture at the heart of TouchDesigner, some elements, in particular the generative visuals, could be reused with some adaptations.

A major evolution of A7 is the use of two instances of TouchDesigner running on the same machine: one running the GUI, the other the main program, both communicating through a message system specific to TouchDesigner via the TCP/IP protocol.

The performance gain is significant, as two instances make a better use of the CPU cores without the complexity that a direct thread management would impose. In addition, the GUI is only displayed at 30 frames per second, which saves resources to display visuals at 60 frames per second.

The practice of Live visuals requires a lot of work beforehand, which is a combination of generative art, pure programming and UX design. However, if there are three distinct parts to this work, both in terms of the skills they require and the issues they raise, and if they take place at different times, these three parts

are closely linked. Over the course of the iterations, each one modifies the others, revealing possibilities, underlining gaps or problems. This work is therefore in constant evolution, constantly rethought, refined and enriched.

3 Architecture

3.1 Program

The program has a modular design and is inspired by video and audio mixers. It allows two generative modules to run and to be manipulated simultaneously.

Whether they generate texture or geometry, these modules deliver a rasterized image at the output, which first passes through a post-processing module, then a compositing module.

The resulting video signal finally passes through a finalization module to adapt the projected image to the projection conditions.

Fig.3 A7 Flow chart

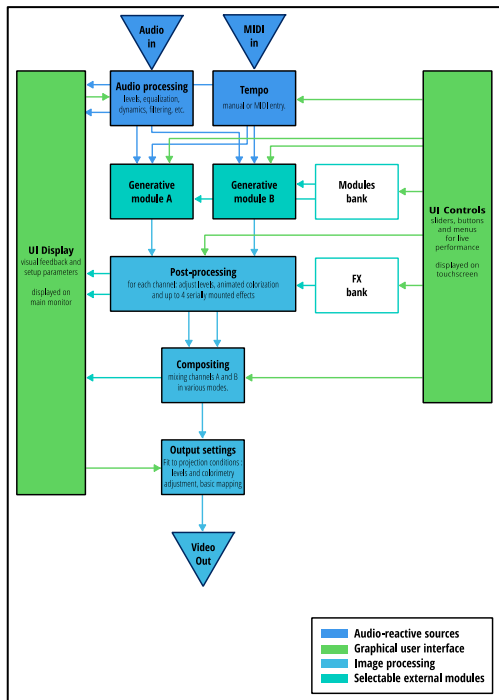
While this design is reminiscent of the A/B model used by DJs, which is widely used in VJing, our practice is not very oriented towards mixing or switching sources. These two channels are generally used in the Preview/Program logic of a video mixer: while a visual runs in a certain configuration on one channel, the other allows to prepare the next evolution.

A recently added module offers a texture bank to feed generative modules that need it. It allows in particular to inject the image produced by a generative module in the one loaded in the other channel. For the moment, this remains rather limited, and needs to be refined and enriched.

The program also integrates a sound processing module that delivers different signals—reference audio, bass, midrange and treble—reprocessed by resampling and filtering to be used as visual parameter controls, as well as the corresponding RMS powers.

In addition, there is a tempo module that allows you to beat the bar manually or to obtain this information via MIDI messages. It produces from the tempo different types of periodic signals enabling to introduce a rhythmic dimension in the visual variations.

The possibility of receiving information from the musician via MIDI is a new feature of A7 compared to its predecessor. For the moment, it is limited to this tempo information, but the long-term collaboration with Jonathan Noé allows us to envisage a more refined work on the relationship between sound and image, an evolution from Live visuals to A/V performance.



The program also includes automation and randomization system, which allows for a partial or total autopilot operation. The development of richer and more complex automation is the main axis of development envisaged in the short term.

3.2 Interface

The design of the interface implies thinking about a use, a “way of playing”. Its goal is to offer a maximum of freedom during the performance while preserving the handling. It is therefore necessary to identify the interesting parameters to be manipulated, but also to imagine the ergonomics that is the most appropriate to the performative practice. It is then easy to understand that interface and performance influence each other, the former conditioning the possibilities of the latter, and the latter revealing the lacks or superfluous functions of the former.

Concretely, the interaction with the program is done through two devices. The Display module is displayed on the computer screen and provides visual feedback and access to basic settings. The Controls module is displayed on the touch screen and presents all the useful controls during the performance: selection of visuals and effects, manipulation of generative modules, compositing...

3.2.1 Display

The Display module offers four video monitors: the final image, the two channels, with the possibility of highlighting the alpha layer and viewing the image before or after post-processing, and a preview of the selected compositing mode.

There are also two groups of three tabs. In the first group, the Audio section

allows you to view and adjust the sound level of the input, bass, midrange and treble, to adapt the smoothing of the signals, and to select the audio input and output.

The Tempo section allows you to switch between tempo entered manually or obtained by MIDI message. It also provides visual feedback of the rhythm in bars and beats, and of the multiples of the beat used by the generative modules.

Finally, several useful controls during startup and initialization are grouped in the Utils section. A Lock allows to block the functionalities in order to avoid any manipulation error during the performance.

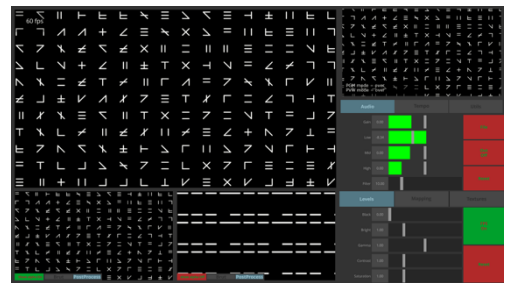


Fig. 4 Screenshot of Display UI

In the second group, the Levels tab allows you to adjust the levels of the image transmitted to the projector, and the Mapping tab to adapt the geometry. These controls are set according to the projection conditions before the performance, and do not affect the feedback displayed on the computer screen.

Added to this is a panel for previewing and selecting the textures provided as input to each generative module.

3.2.2 Controls

The Controls module is composed of three sections: on the left and right, the controls of each channel, in the center

the shared controls. In each section, the most used live features are stacked from bottom to top to optimize their accessibility and reduce the risk of unintentional manipulation.

3.2.2.1 Channels A and B

For each channel, there is a menu at the top to load the generative modules from the library. They are initialized during this loading, but incidents may occur depending on the use of resources that is then made. An error notification system will indicate this by superimposing it on the video feedback of the channel concerned. The Reinit button on the left of the menu will then allow you to correct the problem.



Fig. 5 Screenshot of the A and B channels section of the Controls UI

At the bottom of the section, eight faders and eight buttons can be used to act directly on the generative modules. The parameters controlled are specific to each module, the labels of the controls being updated when they are loaded. The buttons can have three different behaviors: toggle (alternately on and off), momentary (on when pressed, off otherwise) or radio (buttons in a group of which only one can be on). These behaviors are specific to each generative module and are updated during loading.

The section above allows you to navigate between the twenty presets saved for each generative module. Presets include, of course, the sixteen parameters that can be manipulated by the sliders and buttons, but also other parameters that are specific to each generative module and that are not accessible in a performance situation. The Save button is used to save the current configuration. To avoid any manipulation error during the performance, it requires a long press.

Then come the last controls acting directly on the generative modules: four buttons that permit to multiply or divide the frequency of the periodic signals coming from the tempo that the modules use. In order to maintain synchronism, the multiplication coefficient is only applied at the beginning of the bar. It appears grayed out as long as it is not active.

The last section includes four tabs to access the post-processing and automation controls. The first offers four controls analogous to the Aux Sends of an audio mixer. They control whether and how much each effect is applied to the image.

The second tab can be used to adjust the image levels by setting four parameters: black level, brightness, gamma and contrast. The third tab is a dynamic colorization tool. It allows you to adjust the mix of the effect and the source image, the base color of the colorization, the range of the color variation around this base and the speed of this variation. It also has a button to convert the image to black and white.

The Autopilot tab currently offers few features. The Filter slider controls the interpolation between the previous and next value of a parameter when it is changed manually or by loading a new preset. The Filter value indicates the duration of this interpolation in seconds. The P Dur slider sets the display time of a preset when Auto Pilot or Auto PST modes are active.

The Auto PST button automatically and randomly changes the preset. The Auto-Pilot button does the same thing, but also changes the Filter and P Dur parameters on each pull. The Random PST button simply draws a preset at random. Finally, the Random Pars button generates a random configuration of all the custom parameters of a generative module. It is only used in the search phase, and is disabled in performance situations as its results are so unpredictable.

3.2.2.2 Shared controls

The Shared section, in the center of the Controls, is composed of three blocks of commands: at the top, the effect management, below the manual tempo adjustment and below the compositing functions.

The effects section has four tabs corresponding to the four effects that can be used simultaneously. A drop-

down menu allows you to load the desired effect from the dedicated library. Two groups of eight radio buttons are used to select, for each channel, one of the eight available presets.

In the Tempo section, the Tap button is used to beat the bar manually, and the Reset button to synchronize the periodic signals with the beginning of the musical bar. Four buttons are then used to adjust the resulting tempo in steps of ± 1 or ± 0.1 bpm.

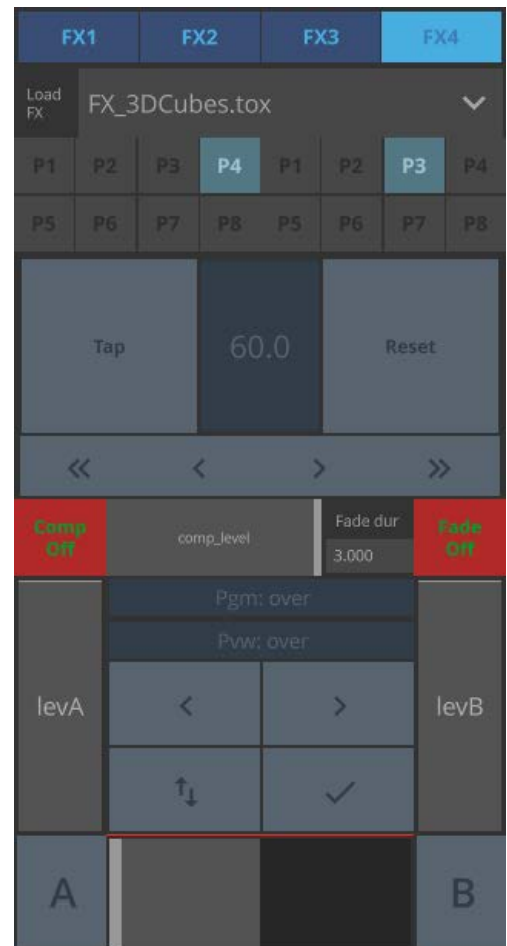


Fig. 5 Screenshot of the Shared section of the Controls UI

In the Compositing section, the horizontal slider controls the crossfading from one channel to another. On either side, a button allows instant switching. The two horizontal sliders are used to control the replacement of the alpha layer by black for each channel, which can have a significant impact on the result of compositing operations.

Above the horizontal slider, four buttons are used to select the compositing mode for both channels. Two buttons allow you to navigate through the forty-five available modes, and a third reverses the order of compositing operations for modes where this order is important. The resulting setting is previewed in the Display window. The last button validates the selection.

A final series of controls is used to activate or deactivate compositing, and to adjust the level of mix between the source image and the composite. Added to this line is a Fade to black button whose duration is adjustable. It is normally only used at the beginning and end of the performance.

3.3 Generative Modules

The generative visuals are at the heart of the program, they are the artistic material from which the improvisation will be built. They are conceived upstream in a generative approach—putting parameters in relation, using chance—, and integrate an audio-reactive dimension.

The characteristics of the music—frequencies, levels, tempo—influence the visuals produced to propose a synesthetic experience. The objective is to continuously compose new ones in order to enrich the palette available during the performance.

The creation of the visuals often takes place initially outside the main program. From a concept, a technique or an idea of rendering, a process of research and experimentation begins, leaving a large place to serendipity. This work continues until it begins to settle, to find a satisfactory outcome.

In order to be inserted into the main program, and to be manipulated in real time, these generative modules must then be normalized. Each one has audio, RMS and tempo signals as input, as well as a texture, and provides a video image as output. They all have their own parameters, sixteen of which can be modified by the interface: up to eight controllable by sliders, and eight others by buttons. When the module is loaded, the labels of these controls are updated with the parameters they modify.

The possible combinations of these controls lead to a wide variety of renderings, and it can sometimes be difficult to retrieve a particular configuration.

This is why I added a system that allows to save and load twenty presets for each of the generative modules, as many milestones set along the exploration of their potentialities, whether it is done during the performance or before.

3.4 Effects

The post-processing effects are built on the same logic as the generative modules: they have their own parameters, their control by the interface is standardized, and they can be loaded on the fly from a dedicated library. Some are extremely simple, such as the feedback or edge detection effect, others are more complex, using the input image as material applied to 3D scenes, or including an audio-reactive dimension.

Each one has eight presets for ease of use. A possible evolution would be to allow a finer parameterization of the effects during the performance, without bringing too much complexity that could harm the ergonomics and the expression of spontaneity.

4 Concepts and theoretical approach

4.1 Generative approach

The generative approach is at the heart of our work. It translates into the massive use of systems aiming to introduce autonomy at all stages leading to the final visual, to set up a complex system of interactions and interferences constantly updating the visual configuration.

These can be simple random draws. They are then generated by the Random module of Python, paying particular attention to the management of the seeds so that no parameter uses the same one.

We also use noise generating algorithms (Sparse, Brown, Perlin, Simplex...) or sets of logical-mathematical operations trying to simulate complex systems, i.e. perfectly deterministic systems, but whose sensitivity to initial conditions makes their evolution unpredictable.

Or even systems of interactions between periodic signals which, although perfectly predictable from a theoretical point of view, generate extremely varied and often unexpected configurations as soon as they are sufficiently complex and the frequencies used are close.

If audio signals are most often used to establish identifiable interactions between music and visuals, they can also be used as a basis for generative systems as soon as we remove, by

various processing operations, the characteristics recognizable by the ear.

This is the case, for example, for the character strings used for the visuals of Jonathan Noé's concert. The audio signal is resampled to the desired number of characters. The last three digits of the numerical value of each sample are transposed into the chosen interval — from [0-1] to [0-254] — each sample thus generating one of the 255 possible signs included in a font we made before by generating all the combinations of eight fundamental lines.

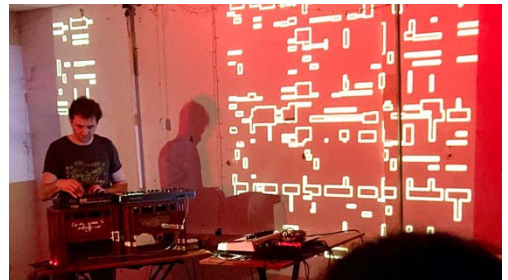




Fig. 6-9 Four views of the A7 in action with Jonathan Noé.

4.2 Control and Manipulation

Pure randomness has only a very limited visual interest, producing images that are always different, but nevertheless largely similar and only exceptionally offering a singular character. It is therefore necessary to tame it, to dose it, to constrain it in an ordered system. For it is indeed the articulation of chance and rule, the implementation of a “programmed chance” that is at the heart of the generative approach.

Although the interface offers multiple possibilities for manipulating the displayed configuration, the vast majority of the parameters determining the visual, either static or dynamic, are fixed in advance. The choice of those that can be modified in real time is crucial, as are the limits within which they can vary. It is on these controls that the performance will be built, in particular those of the generative modules whose progressive deployment in accordance with the music is the foundation of our approach.

4.3 Composition, Improvisation, Comprovisation

The practices of VJing, Live visuals and A/V performance are all performative. The distinctions that we have previously introduced are based in particular on the degree of preparation of these performances and of collaboration with the musician, i.e. the balance that they establish between composition and improvisation.

These two terms are generally perceived as opposites. To improvise is to seek out or provoke the unexpected (improvisus), whereas to compose (compono) is to put together elements, to build a whole. This opposition refers to an outdated conception of the work of art considered as a finished object, under the total control of its creator, a conception that composers such as John Cage have shattered since the 1950s [6].

The two notions now seem more complementary than opposed. How can one improvise without first having a musical experience made of long hours of practice or theoretical learning? How can one compose without being able to invent new motifs in the moment? Improvisation is built on experience, composition organizes the moment's emergences. Both coexist in musical performance, which leads Sandeep Bhagwati to introduce the notion of “comprovisation”:

“The terms “improvisation” and “composition” can be useful as mental constructs but they can confuse and cloud the realities of music making mainly because they suggest that they are somehow dualistic, even antagonistic entities-where in reality they constitute points along a continuum. Using the term “comprovisation” can make us aware of

the contingent nature of this continuum: the fact that the term is so blatantly mongrel immediately leads to the question: how much and what is composed and how much and what is improvised in a given performance? And this uncertainty may prompt us to listen and look more closely at the individual moment of performance.” [7]

These observations apply perfectly to the various forms of visual performance we have discussed, and are entirely consistent with the directions we have chosen and the way we look at our practice.

5. Conclusion

Like musical improvisation, visual improvisation requires regular practice in order to develop sufficient familiarity with the program and the interface to master its productions, to anticipate the result of the manipulations carried out in order to organize the emergence of the unexpected without letting oneself be surprised. It is a question of acquiring a form of virtuosity that allows one to unfold the thread of a visual narrative inspired by music, in the perspective described by Pierre-Paul Lacas, for whom:

“in improvisation, composition and execution coincide: the fingers execute what the mind seems to decipher on a secret score that would be printed at the very moment the instrument expresses it”. [6]

While the preliminary stages allow for the reworking of every detail to get as close as possible to the desired result, while

the unfortunate error is easily made up for, the performance implies risk-taking.

Concentration and attentive listening are essential to let oneself be carried by the music while making the visual production evolve, and constantly correct, by small touches of control, an unstable equilibrium in order to ride the sound wave.

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Jardim das Cartas: generative and interactive installation in mixed reality for music and dance

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Abstract

Developed within a collective and collaborative creative process involving dancers and musicians, *Jardim das Cartas* (Garden of Letters) is a generative and interactive installation in mixed reality created initially to break the social isolation caused by the pandemic. It is an environment driven by a computer system and network technology allowing virtual and live visits and immersing performers (dancers and musicians) in several layers of audio-visual projections.

1. Introduction

Jardim das Cartas was conceived to break the Covid19 pandemic social isolation when artists from all over the planet created and performed inside their homes. Starting in June 2021, its seed materials consisted of a database composed of excerpts from video and audio recordings. Initially guided by the poem "*Cartas à Presença*" (Letters to the Presence) written by Manzoli, a series of videos using computer editing tools for audio-visuals was named "visits" to the digital and virtual garden [1][2] presented in the official channel of the project¹.

The article describes an artistic research perspective [3] focusing on an autoethnographic approach [4] to discuss the creative process unfolding. Gradually, due to the reduction of social isolation restrictions and the development of new compositional and performance methods, the research evolved from remote interactions among dancers and musicians until reached an installation at the UNICAMP Art Gallery in July 2022. Thus, *Jardim das Cartas* can be presented in a virtual gallery, in a physical exposition, or in both situations, with performers in remote and virtual locations simultaneously. That means, an

installation in mixed reality.

The next two sections present the theoretical background and a description of the generative computer system with two main programs and a mobile application. The last section is an autoethnographic report on the compositional process presenting three phases of the project. The project official website can be accessed in the following link².

2. Theoretical Background

The project reported here derives from two previous works: "*Synthetic Oracle*", an interactive installation exploring the mixed reality anchored on the effects of implicit and explicit interactions [5], and "*Ode to Christus Hypercubus*", an interactive performance environment shuffling digital files producing audio-visuals driven by a generative computer system [6][7].

In a previous article [1], we introduced *Jardim das Cartas* discussing the opposition between virtual Presence or Telepresence with the scenic Presence of music and dance. *Jardim das Cartas* also dialogues with the primordial concept of *Panta Rhei* by the philosopher Heraclitus (c. 535 – c. 475 BC) [1][2], the thoughts of Deleuze and Guattari [8], and the Ecology of Perception [9].

The creation of audio-visuals started with recordings of videos, recitations of the original poem, and musical instrument solos [1]. The goal was that, as soon as possible, these artists interact with each other. In parallel, we developed a computer system and a mobile application to allow virtual and live interactions among dancers and musicians. We also intended to induce a perception of immersion in dance, video and generative music. So, the idea was

to generate audio-visuals producing a net of meaning upheld and reiterated by the visual and aural modalities. Spectators listening to music and contemplating videos were exposed to a garden of multitudes: a digital ecology.

We already discussed the theoretical viewpoints supporting *Jardim das Cartas* under the Ecological Theory of Perception [2], which defines perception as the product of a continuous flow of actions in complementary relations between the animal and the environment [9]. According to Gibson, the perception of the environment inevitably leads to some course of action. He introduced the notion of affordances as the environmental properties indicating possibilities for action and perceived directly and immediately, without a priori cognitive processing. We understand in *Jardim das Cartas*, the environment (the garden) becomes a space for exploring multimodal experiences, inducing visitors and performers to immerse themselves in sounds, movements, and videos. It is also an open work, as the final assembly takes place during an exhibition allowing simultaneous and remote participation of several performers.

3. Generative Technology

The computational system developed for the project uses a non-sequential and non-deterministic procedure to access the audiovisual database. It acts as a generative agent recreating combinations of the stored material.

3.1 Main Generative Systems

The system, consisting of two programs implemented in Pure Data (Pd), a visual programming language developed by Puckett [12] and TouchDesigner computer graphics platform, generates music and video in real time,

respectively. Pure Data (Pd), widely used by musicians, and sound artists, is an open-source project with a large developer base working on new extensions.

The TouchDesigner, developed by the Toronto-based company Derivative³, and also used in Generative Art, is a node-based visual programming language for generating real-time interactive visuals (see tutorial⁴).

In live performance, these two programs allow the real-time interaction of audiovisuals with musicians and dancers and control a mixed-reality environment for virtual, presential, and telematic interactions.

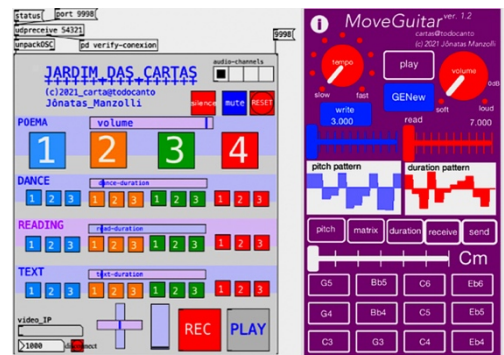


Figure 1: GUI of the Pure Data program to control the generative audio system (left). GUI of the MoveGuitar App allows the performers' local and remote interaction (right).

3.2 Mobile App: MoveGuitar

An application running on mobile devices communicates with the two main computer programs. It was also implemented in Pure Data (Pd) using the Mobile Music Platform (MobMuPlat) by Daniel Iglesias [13]. Figure 1 shows the GUI of the MoveGuitar App that runs on iPads, iPhones, and Tablets, devices

with Mac OS or Android systems. Similar to previous work [6], it allows real-time interaction between the two main programs with mobile devices during live performances. It provides a wide field for expression and interpretation: performances in a concert hall with musicians and dancers interacting only in the acoustic domain or a multimodal assembly in which performers interact locally and remotely. Such use of mobile devices in interactive performances dialogues with the recent creation of laptop orchestras [14][15].

The development of the mobile device began with an app to manipulate sound samples remotely using granular synthesizers called grainBirds [16]. Later, inspired by African music patterns, we developed the MoveGuitar app dedicated to performances involving movement and rhythm. The app generates pitch material with pentatonic scales that dynamically change tonal centers. The rhythm is generated by cycling a 12-patterns of beats. The user controls pitch and rhythmic patterns drawing on the app GUI (see figure 1).

Therefore, the architecture of the interactive and generative system includes the two main programs and the mobile app (see figure 2). It uses network technology for data exchange and interaction between musicians and dancers (locally and remotely). The communication between the two main programs and mobile devices uses the Open Sound Control (OSC) protocol within a local WiFi network, and remote communication using a VPN connection, as described in [16].

The development of the two main programs and the mobile one allowed the creative and performance processes unfoldings. These two systems gradually

incorporated three compositional phases described in the next section. We initially focused on building an audiovisual database, and later we created virtual visits shared on social media in a virtual gallery. Next, we tested the mobile app with dancers as they played them as digital musical instruments and video cameras. Finally, we integrated all these approaches, thus enabling performance in mixed reality (see figure 2).

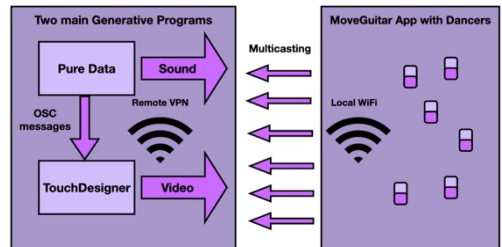


Figure 2: General Architecture of the generative system allowing mixed reality performances

In short, the generative technology of the project supports the live and remote performances of musicians and dancers. If it is set up as an installation, it is presented in a room with a large screen for video projection and loudspeakers for sound diffusion around the visitor. The environment must have very little light because most of the lighting comes from the projectors, and with hidden loudspeakers, visitors don't know where the sounds come from (see figure 3).



Figure 3: Installation montage at the

UNICAMP Art Gallery

4. Autoethnographic Reports

This section describes how the compositional process of *Jardim das Cartas* evolved over almost two years. It is interesting to dwell on the creative path to understand how the transition from remote to face-to-face performances happened until the mixed reality installation. We invite readers to watch the video visits, indicated by links at the endnotes, before reading the following autoethnographic reports.

The compositional process has three phases: 1) visits from 1 to 12: the seed material described in [1], 2) visits from 13 to 21: the transition from remote to hybrid interaction, 3) visits 22 and 23: the installation in mixed reality.

4.1 Seeds of the Garden

The creation of the first 12 visits, during the social isolation, started with a concept of multiple semantic associations to the poem “*Cartas à Presença*” (Letter to the Presence), written by Manzolli [1]. Addressing the Presence of four universes of sensations: *Oceans, Mountains, Winds, and Magma*, it dialogues with Heraclitus’ Panta Rhei (see Visit 1⁵).

Later, we developed a methodology based on creative triggers: a set of color cards sent only to one dancer without repetition and without knowing who received the cards. When receiving a card, dancers recorded a video clip and sent it as an answer.

The resulting video database was recorded by 15 movement artists, including 06 teachers, 06 post-graduate, and 03 undergraduate students, almost all from the Institute of Arts, University of Campinas (UNICAMP). It was created by

dancers representing diversity, especially in dance languages, age, and ethnic-racial roots. Shortly, in the first creative phase, we related the four elements associated to the seed poem to different digitally recorded files: poem narration, environmental sounds, musical instrument solos, and video clips (see a compilation of the initial visits⁶).



Figure 4: Mosaic of images from the first phase of the project

4.2 From remote to hybrid interactions

The first face-to-face performance was in November 2021. Visit 13⁷, carried out by two dance students under the guidance of Andraus, proposed an interaction using costumes and cell movements from the previous remote video recordings. The dance duo promoted a dialogue between remote and live elements through the recurrence of similar movement matrices in a different context within an open-air performance. The music features excerpts from previously recorded material, highlighted voice narrations, Sprechgesang voice, and electric guitar solos.

Next, visits 14 to 19 focused on begin to deal with the exploration of MoveGuitar app (see previous section). Visit 14⁸, created from a poem written by Manzolli celebrating the reopening of the UNICAMP “Teatro de Arena”, articulated instrumental (piano with extended

techniques) and environmental sounds with rhythmic patterns generated with the MoveGuitar. It resulted in a sound-layered structure similar to live electronic music.

Visits 15 and 16 follow the same approach as Visit 13: they took up gestural and body matrices from previous video recordings. In these two visits, Gatti and Andraus dance separately: performing two solos without meeting each other in person. After, their videos were mixed with those of the original recordings, evidencing the permanence of the previous choices - not only those referring to movement but, for example, clothes, hairstyles, and objects. In these two visits, especially on Visit 15, environmental sounds were predominant: wind, birdsongs, and sounds from dancers' movements. Nevertheless, on Visit 15, there are momentary overlaps of instrumental sounds (piano, flute, vibraphone with bow, and electric guitar solos). On Visit 16, we listen to punctual rhythmic patterns generated with the MoveGuitar. We highlight that on Visit 16, a new interaction between the two dancers began: one produced the sounds with MoveGuitar, and the other shot the movement with a mobile.

Visits 17 and 19 complements each other, promoting interaction between the two dancers (Gatti and Andraus) using their mobile for shooting and sound production. These visits maintained the original costumes and some seed of movements from the original video recordings but with progressive flexibility. It gave space to construct new gestures from the dance point of view from the contingencies imposed by the mobiles as technological mediation devices, objects, and new scenic situations.

Visits 20 and 21, which are also complementary to each other, were presented at the improv@CIRMMT⁹ on March 15th, 2022. In a virtual and collaborative process, the artists participated in several complementary ways: dancing, performing, and video shooting and generating music with the MoveGuitar, the piano and the computer, remotely. The Pure Data program of *Jardim das Cartas* (see the previous section) was the host sound generative engine. It received Open Sound Control (OSC) messages from performers placed in Brazil, Canada, and Portugal through a VPN communication as described in figure 2. The complementarity of these two visits (named Anteverso and Verso) resides in the fact that, while visit 20¹⁰ aims to show the backstage of the interaction, visit 21¹¹ presents the poetic version of the interaction.

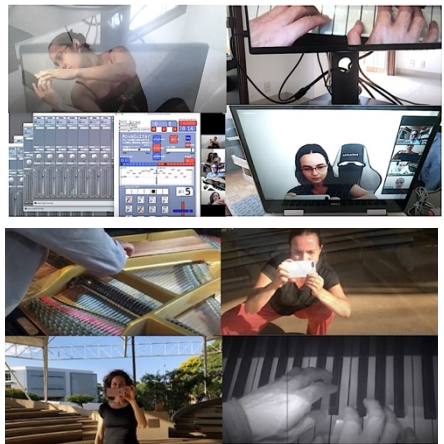


Figure 5: Mosaic of images from Anteverso and Verso, visit 20 and 21.

4.3 Mixed Reality Performances

For the exposition at the UNICAMP Art Gallery, we developed two mixed-reality performances with musicians and dancers in telepresence and live presence within the exposition space

(see figure 3) with digital and computational sound and visual mediation. A dance ensemble, a live soprano sax, and remote musicians (piano and live computer music) integrate Visit 22¹². A duo dance performance with live and remote musicians (piano and computer music) is Visit 23¹³.

The mixed reality orchestration of the two performances took place in a hybrid environment comprising different languages of dance, music, sound, video, poetic narration, mobile devices, and the two generative main programs. All these elements shared physical and virtual spaces promoting at the same time action among all performative agents interlacing each other.

A multimodal symphony embodied and virtualized, in which sounds, movement, and live/virtual images created expressive layers during improvisation in tune throughout the performance. The multimodal elements: sax soprano, piano, two generative computer programs, mobile devices in interaction, and recorded voices starred the sound reality in a horizontalized and rhizomatic interaction with the physicality of movements of dancers' bodies, live and virtualized ones. A duo and dance ensemble with 05 live dancers on the installation interacted with video projected on three screens.

Each video created and edited was composed in a direct relationship with Manzolli's four-letter poems related to the four elements of nature (water, fire, earth, and air) and which were propellers of the Jardim das Cartas project, see [1][2]. And for the mixed reality performances, we rescued these four elements within a dramaturgical proposal for dance improvisation in the installation. A draft script served only as a guide describing a

macrostructure of multimodal improvisation and the potential links between the communication network within the performers. Nevertheless, we explored the non-linearity and unpredictability of the dance and music improvisations.



Figure 6: Mixed reality duo performance

On Visit 23, the dance duo Gatti and Andraus interacting with each other enlarged the context developed in the previous visits (14-21): MoveGuitar app played by Gatti produced rhythmic patterns, and Andraus shot the movements sent to the projected screens (figure 6). We used the Zoom platform to establish a communicative bridge among performers introducing two virtual elements: the telepresence of Zamith's virtual piano performance from São Paulo, Brazil, and the virtualized and improvised sounds by Manzolli's telepresence run the Pd program (see the previous section) from Coimbra, Portugal. Both sound materials diffused on a quadriphonic-loudspeakers system generated sound sewing in such a musical improvisation took place in a hybrid and telematic way, such as a symphony enlarged in space.

In visit 22, two more sound layers included in the improvisation were: the live presence of Faleiros' sax soprano, who improvised along the sounds

created with the MoveGuitar played by Gatti and the dance ensemble.



Figure 7: Mixed reality performance with live and remote musicians

5. Discussion

Improvisation in mixed reality brings some interesting points regarding the exercise of body perception at the moment of action. Performers perceive the state of presence in the relationship to live and virtual environments, promoting the expansion of attention and anticipating movement production. Thus, their bodies act as vehicles of dialogic communication between two dimensions of presence (virtual and scenic). During the two mixed reality performances, the generative technology interacted with performers in three situations as follows:

- 1) dialogue of dance, music, and video projections: actions were extensions of the physical and virtual environments, and bodies producing movements were affected by video, sax improvisations, and sound generated in real-time. There were also merges of the screen

projections of virtual bodies with shadows of the physical bodies (see figure 7).

- 2) the bodies acted as extensions of mobile devices: gestures created with the MoveGuitar through accelerometer sensors of the phonecells performed as a digital music instrument. The force demanded by the dancers' hands and the impulses in the movement concatenation generated specific and unique sounds.
- 3) dance and music improvisations harmonic and inharmonic counterpoint: since relationships were unpredictable at each moment, improvisations with movements, piano, sax, and computer-generated sounds, allowed the performers to listen to different sound layers leading to different poetics of sound and movements.

Shortly, dance and music dialogued with the projected movements on the screen and the sounds recorded previously. Everything was connected: virtualities and realities generating kinetic energy where sound and movement happened as forces of virtual and scenic presences.

6. Conclusion

We presented *Jardim das Cartas*, a collaborative-creative process involving dancers and musicians. In the resultant generative and interactive installation, spectators and performers contemplate and interact with music and video generated by a layered network of digital material exposed in a virtual and live garden for multimodal interaction. This idea is an aspect of *Jardim das Cartas*

discussed in [11] when it is stated that any experience brought by artwork is always multimodal. It sustained by an argument on how visual modality influences the auditory processing of music. *Jardim das Cartas* is a generative and open work, as its final assembly takes place during an exhibition allowing simultaneous and remote participation of several performers. Moreover, *Jardim das Cartas* still opens new experiences in sound and movement. It recreates new sounds, gestures, and movement elements allowing new interactions among dancers and musicians. It rebuilds new environments inducing new interactions among performers and new perspectives in a trajectory of multitudes.

Acknowledgments

The creation and production of *Jardim das Cartas* involved 23 dancers, 05 voice artists, 05 musicians, and 03 computer designers and TI support who, since June 2021, within social isolation, have been willing to collaborate in this project. We thank all of them. It follows their role and technical credits in the creation and performance.

Dancers in the video clips: Adnã Alves, Andrea Albergaria, Cassiana Rodrigues, Clara Rodriguez, Daniela Gatti, Flávia Pagliusi, Gabriela Freitas, Kamilla Mesquita, Mariana Baruco, Marília Vieira, Milena Pereira, Paula Ibañez, Rafael Lemos, Stephanie Borges, Vania Pontes, and Vine Hernani; Live dancers in the installation: Rafaella Ferreira Costa, Maria Isabel Torres dos Santos, Nicolly Karoline Moreno Lapa, Isadora Alonso Faustino, Ana Luiza Gomes Przsiczny, Daniela Gatti, Mariana Baruco; Voices reading the poems: Andrea Albergaria, Joana Lopes, Mariana Baruco, Paula Ibañez, and Laiana de Oliveira (sprechgesang); Musicians: Alexandre

Zamith (live Piano), Beatriz Maia (recorded Soprano voice), Cesar Augusto Pereira (recorded flute), Fernanda Vieira (recorded vibraphone), Leandro Ligocki (recorded Electric Guitar), Jônatas Manzolli (recorded piano), and Manuel Falleiros (live saxophone); Computational systems development: Jônatas Manzolli (Pure Data implementation) and Guilherme Zanchetta (TouchDesigner implementation); Network support and computational assembly: Edelson Constantino and Guilherme Zanchetta; Research Groups PPG Performing Arts IA/UNICAMP: Intercultural Studies in Presence Arts and R EDES Dance Group.

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³ Derivative website: <https://derivative.ca/>

⁴ TouchDesigner Tutorial: <https://www.simonaa.media/tutorials/daily-practice>

⁵Visit 1: <https://youtu.be/AMNDXL70OSY>

⁶ Compilation of first visits:

<https://youtu.be/eV3ziAgg5iM>

⁷ Visit 13: <https://youtu.be/ldKMXLMDcVU>

⁸ Visit 14: <https://youtu.be/JJ9-AYeWrm>

⁹ improv@CIRMMT - Special Online Edition:

<https://youtu.be/YclfZtDTHcU>

¹⁰ Visit 20: <https://youtu.be/xQCD5oigeNg>

¹¹ Visit 21: <https://youtu.be/0cd1N1AK4xM>

¹² Visit 23: <https://youtu.be/x0zMt25yhal>

¹³ Visit 22: <https://youtu.be/VQJvuHcsy-4>

Blomster (Performance) & (Installation)

Topic: (Moving Image, Music & Dance)

Kathryn Ricketts, Angel Ferraiolo & Arne Eigenfeldt

University of Regina, Canada
Simon Fraser University, Canada
Sarah Lawrence College, USA



Abstract

Blomster is a beautiful word and rolls around in the cavities of speech like a plump gum drop. It is the Danish word for flower and became the core of a choreographic work with Kathryn Ricketts' Danish dance company 30 years ago on a stage laden with fresh flowers. The intricate patterns of dancers in white, moving through metaphors of garden life: the weeds, the buds and the blossoms, was accompanied by the words of an 85 year old gardener with proud and loving descriptions of tending to his lifelong garden. This work

has been transported and reconfigured into the present with Angela Ferraiolo's brilliant digital and everchanging gardens and Arne Eigenfeldt's stunning generative soundscapes. We are exploring the timelessness of nature within a digital age and the many human relational metaphors that not only endure but thrive as we move into a future that threatens social austerity.

Last year we attempted to show a virtual version of this work in progress in Generative Art in 2021 but this session was compromised due to technical difficulties. We are now excited to be performing this in person with

a more refined and complex conglomerate of visual, audio and kinesthetic elements. We are also excited to share how this collaboration has evolved and deepened over the last year.

This presentation is also in the form of an installation which is on a micro projector and sound system and is very mobile so could be part of a reception on a wall or a ceiling.

Video Links

<https://youtu.be/zf4WFEC28tl>

https://youtu.be/ljXD_2HWXxM

<https://youtu.be/dwBPAQbuw50>

<https://youtu.be/AUK2Z5lriSY>

<https://youtu.be/9xHVdvn7hx4>

rickettk@uregina.ca

**Key words: Installation,
Generative Music, Dance
Improvisation, Multiagent
System**

saltatio unda
(Live Performance)

Topic: Music, Generative Design
labora media Germany www.labora.media



Labora media

Abstract

“labora media” is a group of artists and their mobile laboratory to create interactive media in real time with their own developed instruments, as independent as possible

“saltatio unda” is a performance that creates generative visuals and music from dancing people using own wearables.

The wearables tracking movements of the dancers and recognizing individual patterns to generate rhythm and melody to hear and visualize waves



Key words:

generative music

info@labora.media

Artwork - Symbiotic Chromatics

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Abstract

Symbiotic Chromatics is an artificial life artwork that generates complex emergent patterns in realtime based on simple rules inspired by biological symbiosis. It is easy to install and allows variable scenarios. The 4K image can either be projected for full wall coverage or presented on a large flat screen.

The popular conception of symbiosis is typically limited to mutualistic symbiosis. In such a relationship two or more species support the needs of each other. For example, bees gather nectar from flowers providing them nutrients. But in doing so they rub against the flower's pollen and go on to distribute it to other blooms for reproduction. Both the bees and the flowers benefit each other.

Where Darwinian "survival of the fittest" suggests a harsh world of competition, some find comfort in knowing the natural world also has systems where "everyone wins" through cooperation. This romantic metaphor gives some a sense of hope for an all too often violent humankind.

But as is so often the case, the natural world is more complicated than our wishes and expectations. Along with mutualistic symbiosis there is also parasitic symbiosis where one species preys on another, offering only loss in return. There is also commensal symbiosis where benefits flow in only one direction, but no harm is done in the other.

In this piece only mutualistic symbiosis takes place, but nevertheless there is no utopic happy ending.

Chromatics, a term invented by the artist, are tiny 2D virtual creatures that live on a grid similar to cellular automata. Each has a single gene, a number from 0 to 360. That gene corresponds to a position on a painter's colour wheel and determines the colour of the chromatic.

Chromatics cannot reproduce on their own. Rather, they can only help other nearby chromatics to reproduce, and they do so selectively. A given chromatic is surrounded by four other chromatics (left, right, above, and below), and it will

replace three of them with the species that has the most harmonic colour of the four. However, once in a while the colour gene will mutate, introducing random colour changes in the reproduction process.

(In this piece perfect harmonic colours are those 90 degrees apart on the colour wheel. Other colour harmony rules could potentially be used by changing the code.)

The piece tells a story in two acts.

Initially there is a grid of chromatics that either have random colour genes or are all a single species with the same colour gene. In the first case the random chromatics quickly begin to self-organize. The process of selective reproduction creates checkerboard-like textures, each with two harmonic colours via symbiosis and irregular borders.

In the case where the entire field is a single species and colour, mutations introduce enough variation that irregularly shaped checkerboard-like textures again emerge with harmonic colours. After the first five minutes or so one cannot tell whether the starting point was a single colour or random colors.

The self-organization of these checkerboard-like textures in the first act demonstrates the power of mutualistic symbiosis.

But in the second act something less friendly emerges. At this point colour-harmonic pairs of species have symbiotically teamed up to claim territory. But there is now competition between communities of symbiotic pairs. Mutual symbiosis is still in effect, but harsh battles for territory will wipe out some

colour pairs, nevertheless. Nature is both harsh and nurturing.

It should be noted that an audience can enjoy this piece without having first learned about the interpretations and technicalities spelled out here. The emergence of colourful patterns and the competition between different checkerboard-like textures is obvious to the eye. Some will find themselves cheering on their favourite colour harmony pair in competition. It's a bit difficult to describe, but the updating of dozens of the tiny chromatics per second creates a very satisfying effect something like raindrops hitting the windshield of a car.

1. Installation Requirements

As noted earlier, Symbiotic Chromatics can be configured by the artist for various wall or screen sizes and resolution. This can be done in literally five minutes. It's important that the display be of sufficient size to create a somewhat immersive experience.

The system automatically fades out one instance and then starts again from scratch. That interval can be minutes or hours long depending on the traffic flow and expectations of the venue.

The system can easily be shut down overnight and restarted in the morning by most gallery staff.

The artist can bring the needed computer from the US to Europe, but bringing a large display or projector is difficult. It is hoped that the venue can provide a 4K display or projector that is HDMI compatible. A dimly lit area is preferred to a brightly lit area. The installation does not make sound.

An Agile - Multidisciplinary Approach and Innovative Toolkit to Catalyse Generative Creativity and Change

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Next, an overview of some project cases and concepts part of the author's artist.ai initiative will be presented. Each study is showcased with a research-hypothesis and challenge statement, as well as a description of disciplines involved, and spotlighting key techniques and tools used, such as Artificial Intelligence (AI).

Abstract

This paper provides an overview of an experimental, iterative, and incremental approach: VAMOS TODAS (created by the author) to catalyse creative and innovation projects. At the core of this method are a collection of generative techniques that foster inter-multidisciplinary co-creation, systematic exploration of *hybrid-action* opportunities to craft experiments, new concepts, and artworks. Several concept-projects are discussed to illustrate the approach in action and its results are discussed.

First, we explore the methodological foundation by discussing the key perspectives and value of the VAMOSTODAS.art approach, including examples of how innovative systemic anticipation and adaptative/agile execution practices might apply to a multidisciplinary (generative art) project.



Fig 1. An infinite creative loop!

1. About VAMOS TOD@S.art

The origin of this method goes back to the late 2006 – early 2007, when I was founding my company SpaceMinds and conceptualized a metaphor to design and lead creative projects and workshops for diverse participants to effectively collaborate in innovative projects and transformational change initiatives despite their various organizational affiliations or different backgrounds [1].

1.1 A shared journey!

The SpaceMinds Method/Approach – VAMOS TODOS™ was conceived as a systemic approach to create, define, and lead projects and effective teams with agility. Integrating good practices for agile leadership, participatory innovation, effective project, program, and portfolio management.

The hallmark of this method/approach can be summarized in the phrase (or call to action): ¡VAMOS TODOS! (Literally meaning: “we all go!” or “let’s go everyone!”). It is much more than a simple word search game. This model is based on a metaphor in which its acronym has a profound meaning and offer a simple way to inquire, explore and collaborate in an infinitude of situations (projects, innovative challenges, creative teams, communities, events, etc.) with a method/approach easy to share and apply.



Fig 2. Balancing strategy and execution

In this context, each creative project, challenge, goal to be achieved, or even a simple task to be performed, by an individual, team, organization is approached as a “journey”. A journey that to be successful, must be inclusive and shared by all relevant stakeholders! An idea shared with diverse audiences [2][3][4]

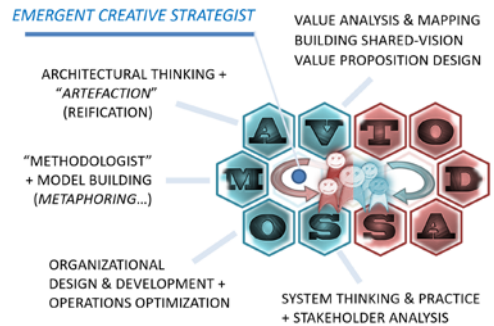


Fig 3. A systemic-strategist mindset for creating innovative change!

Due to its flexibility and systemic vision, the application of this method offers a conceptual open-mindedness and shared language to multidisciplinary and diverse teams, so that applying the principles and practices of VAMOS TODOS, it helps "create bridges" among different areas, units, stakeholders, and organizations to better connect with their expectations, vision/mission and develop value relationships. This way, each creative-innovative project becomes an effective opportunity for growth and development.

VAMOS TODAS.art was created as a variation of the original method/approach applied to the specific scenarios of artistic-creative-innovative collaborations. Participants in the any VAMOS TOD@S programs are invited, thus, to share and enjoy a journey of creative learning, artistic exploration, and innovative value creation!

VAMOS TOD@S includes a set of principle-guided, process-based tools, techniques, and practices. Each one aiming for value creation, describing a sequence of steps or tasks and critical roles-responsibilities to achieve a purpose, some goals, or objectives,

generating the results that most contribute to the success of the projects.

1.2 Agile learning in projects

The information generated and collected in the various processes of portfolio, program and project management have an incremental and evolving nature that is in line with the agile and iterative character of the necessary learning habits to successfully lead and manage such projects. To systematize these capabilities and management habits, five key practice-areas or steps are usually conceived, to facilitate a connection between anticipation (creative strategy) and the project execution (tactics).

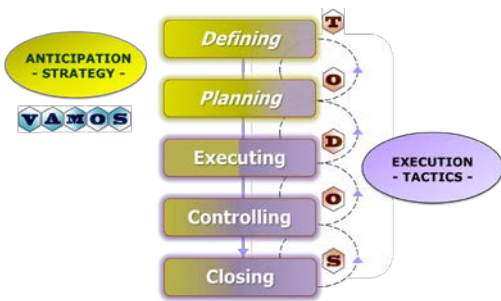


Fig 4. Project management’s traditional “habits” VS. adaptive approaches

2. A portfolio of case-studies

In this section, we provide an overview of some project cases and concepts part of the author’s artist.ai initiative will be presented. Each study is showcased with a research-hypothesis and challenge statement, as well as a description of disciplines involved, and spotlighting key techniques and tools used, such as Artificial Intelligence (AI).

2.1 Case: VAMOS TOD@S Art Creative Experiential Program

This program has been designed using VAMOS TODAS.art method and proposed for an artistic-educational initiative. It has been formulated to support research, mediation, and education work with a multidisciplinary, inclusive, diverse, and participatory approach and the curation of a set of resources, experiences and activity programs around art and education.

Relying on an extensive professional experience educating and working in diverse and multidisciplinary teams, this project is conceived as a space for exploration, inquiry, experimentation, with gamified creative challenges [5].



Scope & Impact	Organization & ecosystems				
	TEAM Personal				
SpotKards "trialbliss" learning approach to architect great teams!	Project-based, STEAM-maker	Experiential learning	Gamified & FUN!	Competency development	Strategy & techniques

Fig 5. Experiential learning STEAM WS

In a context of educational research artistic action learning, and creative production, we explore how the intersection of science, technology, engineering, art, and mathematics (STEAM) education can help provide spaces for multidisciplinary mediation

and co-creation. And thus, turn "potential conflicts" into co-creative opportunities.

This project includes an invitation to ALL people to "(re)educate" themselves with art and transformative experiences, by engaging in projects with various STEAM challenges. Applying in each project stage the VAMOS TODOS.art method by working in multidisciplinary teams.

2.1.1 Program objectives and results

Objective 1. Creation and development of a monthly art and education program that is conceptually integrated within the themes of the art-educational institution and that takes place in the facilities of its cultural venues in Madrid, Spain.

Key results for objective 1:

1.1. Develop a program of monthly mediation, art & educational activities.

1.2. Include various types of participatory activities (conferences, meetings, and workshops-workshops) incorporating co-creative challenges that have a high experimental component.

1.3. The calendar and focus of the activities facilitate the creation of a group of participants that is maintained throughout the academic year.

1.4. The activities will be aimed at intergenerational and family audiences, with alternative variants for various segments of children or adolescents.

Objective 2. Promote production, research and shared learning with other residents and agents.

Key results for objective 2:

2.1. Works are produced in a participatory manner that reflect the diversity of the ecosystem and stakeholder groups of the artistic educational institution (residents, agents, public: anyone, families, adults, youth, professionals, educators, schools, etc.)

2.2. Various resources that support creative, educational and mediation work are investigated, curated/classified and disseminated.

2.3. A learning and exchange community dynamic is established between all the people involved.

Objective 3. Promote the dissemination of good practices related to education, art and the STEAM disciplines for various stakeholders.

Key results for objective 3:

3.1. Generation of an exchange space (forum/blog/wiki) of contents resulting from the project and/or indexed references from the Internet (articles, resources, templates, open-source materials, etc.)

2.1.2 Project scope and deliverables

Project works and assignments are to be done in an agile, iterative, and incremental way. By applying the said methodology for defining, leading and managing creative/innovative projects (VAMOS TOD@S art) and applying a hybrid approach (called "-TLON", See Figure 5) for experiential activities with public participation that integrates challenges with gamification, teamwork and various skills development.

For each thematic area the following activities and deliverables will be developed (iteratively):

A.1. Research: formulation of a research question in the form of a challenge/conflict that will be resolved (hypothesis to be validated/refuted) through art and education. Search and study of reference works, resources, articles, books, etc. for each thematic area of the project (see examples in the section on Program of Activities and/or Thematic Areas).

A.2. Hybrid-art creation: adapt/create personal artistic works (“Work-In-Progress”). Development of artistic concepts and prototypes of hybrid art with opportunities for applications in education.

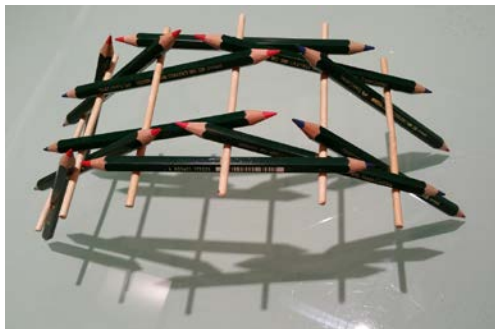


Fig 6. Photo and model created by the author of a scaled DaVinci model bridge built with pencils. Can ART become the “bridge” (link) between EDUCATION and STEAM disciplines?

A.3. Curating art-education resources: Prepare Manifesto, Guide, and Checklist of resources to help participants and educators bridge across traditional educational resources and “new” STEAM applications.

A.4. Experiential learning workshops (“The program”), including two types of activities:

1. Talks/meetings (conferences) that can be face-to-face and/or virtual. The talks present the results of the previous activities, and at the same time create a space for co-creative participation, demonstrating and putting into practice the resources/manifesto/checklists, etc.
2. Experiential Workshops. Co-creation workshops (in person). The Workshops include organized challenges to work for 3-4 hours in several “small” teams in parallel in a space at the institution, with the aim of co-creating a piece/sketch or WIP artwork (work in progress).

Themes for both types of activities:

- VAMOSTODAS.art: Educating with STEAM projects and art in teams!
- Robotic Art with Educational Robotics (Including the Robotlon Challenge)
- Education, Generative Art, and Data (Including the Datatlon Challenge + Case study: Artistv.AI)
- Education, Synthesis and Sound Art (Including the Synthatlon Challenge)
- Sonification and the Art of Noises: Learn to “see” with your ears! (Includes the Sonifytton Challenge)
- Mobile Art with / without WATER: Education and Sustainability (Includes SinAQUAnon.ART case)

- Appreciative Storytelling: stories, questions, and educational artifacts (Includes Storytlon Challenge)
- Education, Artificial Intelligence + Coding-ART and Art with Games (Includes Neutotlon Challenge)
- Conversation with (re)percussion: Ephemeral Art in Community (Includes BONGOTlon Challenge: a ReciclARTE Drum Circle)
- Final Project Presentation: Curation of Community Resources and Collage WIP (VAMOSTODAS.art)



Fig 7. Generated underwater seascapes.

A.5. A participatory WIP (work-in-progress) VAMOS TOD@S art collage: to be created incrementally. As much as possible, the results of the workshops (A4.1) and other own artworks are gradually integrated and hybridized in a digital collective artwork collage. This collage may reside virtually on the creator's website and/or have a physical presence if the institution provides a space (in the institution Artists' RESIDENCE Work Area for example).

2.2 Case: Sin AQUA non-ART!

“Sin aqua non” sounds very similar and reminds us of the "sine qua non", from Latin, which means "indispensable condition without which..." In this context, this motto means "without water there is no art (nor life, no future!)".

In this project, I proposed the use of datasets about water quality to inspire and generate content that was processed by AI-based algorithms and used in combination with NVIDIA Canvas to generate a futuristic metaverse-like underwater journey to create awareness about water pollution and microplastics.

Considering the value proposition “Create awareness about water pollution and microplastics” as well as noted stakeholders – such as UN – and methods/models such as the UN Sustainable Development Goals (SDG), the project “naturally” relates specifically to SDG#6: “Ensure availability and sustainable management of water and sanitation for all” [6] and SDG#14: “Conserve and sustainably use the oceans, seas, and marine resources for sustainable development” [6].

These considerations influenced the proposed scope, strategy and execution of the project to build a visual storyline related to an imagined (but realistic) underwater incursion (“deep sea tour”) in which water quality degrades as time passes and more pollution becomes present.

<p>Table 1. Sin AQUA Non .art VAMOS Strategy perspectives</p>
<p>Values & vision: 1. Create awareness about water pollution and microplastics. 2. Experience a close encounter with a likely future situation affecting ocean ecosystems. 3. Use modern tools to generate artifacts and influential stories.</p>
<p>Artefacts & architecture: Artefacts & assets may include generated graphic artworks and sound-compositions, datasets about water quality, currents, microplastics, deep-ocean mining, etc.</p> <p>Activities may include a virtual underwater (metaverse) tour through time, exploring and exposing visitors to the impact of plastic to the ocean water quality and the related ecosystems.</p>
<p>Methods & models: Artist.Ai's toolset for Data + AI based artworks, various initiatives for SDGs (#6 and #14), agile-iterative creative process incorporating AI/data tools "pre-made" (eg. NVIDIA Canvas, OpenAI ChatGPT, DALL-E...) and/or self-developed algorithms, etc.</p>
<p>Organization & operations: a creative team with partners and collaborators. Other participants can/would represent various stakeholders' groups & interests.</p>
<p>Stakeholders & systems: all public, water-quality related institutions, SME's, NGO's, UN 2023 Water Conference and other stakeholders, generative artists!, tools/platform developers, venues, etc.</p>
<p>VAMOS TODAS – GQ* (a Generative Quotient - like index): 2.562.987 (8,95%) *considering the number of elements in each dimension VS. an "idealized" (5x5x5x5x5) VAMOS TOD@S project.</p>

2.3 Case: VolcaNO/ava.art

Another case-study is this concept-project I designed to pay tribute to the numerous people affected by La Palma volcano eruption (2021), and to those engaged in managing the emergencies caused by this destructive event.

The project includes creating a hybrid-artwork collage integrating analogue and digital elements such as visuals and sonification experiments – generated from volcano-eruption data, and the performance of resulting compositions using KORG Volca modular synthesizers.

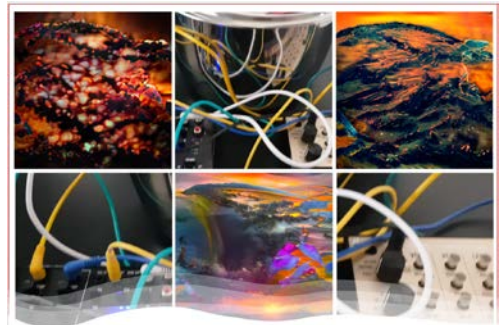


Fig 8. VAMOS TODAS.art projects frequently incorporate a diversity of artefacts. In the case of VolcaNO/ava, it features visuals, physical synth modules, sound/sonic performances, etc.

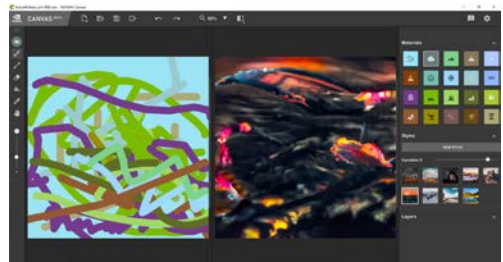


Fig 9. Creating LAVA-like scenery with AI support, by NVIDIA Canvas (Beta).

Table 2. Volca-NO-lava VT dimensions
Values & vision: 1. Don't forget La Palma! 2. Appreciate the work of many people from scientists to emergency personnel to neighbours and volunteers.
Artefacts & architecture: Artefacts & assets may include generated graphic artworks and sound-compositions, datasets about volcano activity, etc. A visual & sonic generative performance.
Methods & models: Artist.AI's toolset for Data + AI based artworks, agile-iterative creative process incorporating AI/data tools, sonification tools and/or self-developed algorithms, MIDI, etc.
Organization & operations: a creative team + optional partners/collaborators. Performance attendants from various stakeholders' groups, communities, etc.
Stakeholders & systems: La Palma residents, Vulcanologists, Scientists, other stakeholders, generative artists!, tools/platform developers, venues, etc.
VAMOS TODAS – GQ (a Generative Quotient - like index): 1.240.155 (4,33%)

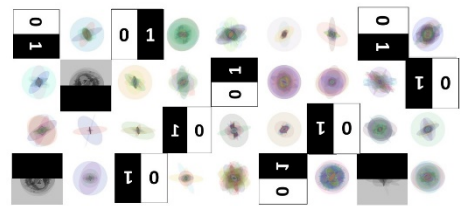
2.4 Case: FALLsonancia

This case-study includes an evolution and a status update of a generative art-based project, namely NOfall.art (created by the author and presented in GA2021 [7]). The motivation for the original project relate to the serious challenge of falls in adult population and the importance of raising awareness to avoid or reduce related risks and fears.

Various diverse perspectives are considered in the project, such as the relationships of that work with the increasing demand for “Responsible AI”,

as well as connections to UN's Sustainable Development Goals, and references to the author's previous research on AI-based Fall Detection Systems (FDS) using open-data FALL-ADLs (activities of daily living) datasets.

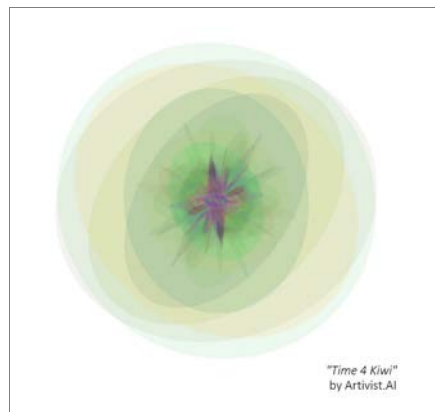
In these new “experiments”, we explore the use of sonification to continue our journey into raising awareness of fall-prevention.



"Falling Soundscapes" by Artist.AI

Fig 10. Soundscapes from fall data

In this iteration, we use open data assets about falls, AI & data science techniques to perform experiments with tools such as Google's Magenta Studio, AWS Deep Composer, the new OpenAI's ChatGPT (see Annex 2.), Ableton Live, etc.



"Time 4 Kiwi" by Artist.AI

Fig 11. KIWI, Fall or ADL (Activity of Daily Living)? What's your best guess?

Table 3. *FALL*sonanCIA VT dimensions

<p>Values & vision: 1. Create awareness about fall prevention 2. Generate sonic experiences to appreciate discordant events, such as an accidental fall.</p>
<p>Artefacts & architecture: Artefacts & assets may include generated graphic artworks and sound-compositions, curated datasets about falls, updated website, generative sound performance.</p>
<p>Methods & models: Artist.AI's toolset for Data + AI based artworks, agile processes using sonification, AI/data tools, self-developed algorithms, MIDI for composition, OpenAI ChatGPT, etc.</p>
<p>Organization & operations: a creative team + optional partners/collaborators. Performance listeners from "target" stakeholders' groups, communities, etc.</p>
<p>Stakeholders & systems: Just about anyone!, healthcare professionals, other HC stakeholders, generative artists!, tools/platform developers, venues, etc.</p>
<p>VAMOS TODAS – GQ (a Generative Quotient - like index): 1.271.403 (4,44%)</p>

At the heart of this project stands the serious challenge of falls in adult population and the importance of raising awareness to avoid or reduce related risks and fears. As pointed in GAC2021, the starting spark of this initiative was a recurring question that I have been "brooding" for quite some time. Namely: "Can AI, data and art be *hybridized* to influence change for good purposes?" [8] and this sonification "turn" pretends to deepen the quest for answers with "new" (auditory) senses.

3. On generation of new ideas

The generation of novel ideas has been the focus of many previous research and proposals. Many of those has inspired and influenced my work in the development of the VAMOS TODAS method/approach. Below some of valuable resources are mentioned.

HIT (Heuristic Ideation Technique): this work was the results of a research thesis by the author [9], popularized in the marketing community by a short, but influential paper in 1972 [10], where HIT was presented as a systematic procedure for exploring and selecting new product ideas [10]. The HIT procedure itself follows a simple, yet systematic approach to generate ideas for new products by identifying all combinations of a product-market significant dimensions and selecting the most promising ones.

Innovation "habits": Various authors have tried to nail down the keys to innovation. Due mention is needed to the "The Innovator's DNA" [11], a book enriched from over two decades of the authors' research. Their findings point to five "Discovery Skills" (Questioning, Associating, Observing, Networking, and Experimenting) which are behaviours consistently performed by innovative people. From years of experience applying these skills and sharing them with colleagues and students, I can only agree with the authors on how these contribute to anyone's ability to generate novel ideas which are often disruptive.

Oblique Strategies – the reputed card-based method for promoting creativity jointly created by musician/artist Brian

Eno and multimedia artist Peter Schmidt, first published in 1975 is as simple as one may imagine. Take one card at a time to be faced with provocative suggestion (a phrase, question, or remark) which if appropriately considered or “challenged” will likely spark some new ideas. Another angle from this inspirational source is that if you look at the history of it (the subsequent versions, variations, formats, etc.) it points to other attributes of creative works, which are: evolutionary and incremental [12].

Adaptative methodologies: In relation to the previous fact, one must consider that incremental-iterative development is one of the foundations of agile & adaptative methodologies and another key attribute of the VAMOS TODAS approach. The next resource is a 1986 paper by Hiroataka Takeuchi and Ikujiro Nonaka, recognized as a milestone in exposing how important it is (was) to reconsider how we developed “new” products, using this kind of approach, and where a development team works together as unit to achieve common goals [13].

Questions to challenge assumptions: Another set of valuable resources are those that explore and address the role of questions in igniting change and creativity. One such example is the already mentioned work on Innovator’s DNA [11], and other valued references include Leading with Questions [14]. One interesting observation in this work relates to a leader’s attitude when asking questions. Particularly, if a learner’s attitude is adopted (versus judging), the questions can have a major positive impact on the participants perception and their contribution.

“By consciously adopting a learning mindset, we can become more open to new possibilities and ask questions more effectively... The flow of information and ideas will open up, and problem solving, teamwork, work, and innovation will be enhanced” [14] - states Marquardt.

Systemic modern theories: Such as Integrated Information Theory (IIT) [16] aiming to explain consciousness. VAMOS TOD@S is a systemic approach effectively integrating all the information of a project ecosystem for generating “large” number of ideas (See Annex 1.) and new levels of team consciousness.

However, there is a “tension” between these “strategic” generative activities and their “execution” of those ideas. VAMOS TOD@S approach also deal with these challenges by facilitating several “TOD@S” loops or iterations to incrementally deliver the value expected in these projects and reduce risks.

4. Conclusions are WIP

Having a diversity of resources (such as generative art techniques) are indeed a way of reaching and influencing larger diverse audiences to become and act more creatively in their innovative tasks.

The presented VAMOS TOD@S approach, as a “living” work-in-progress toolkit, offers an open-ended space for future initiatives and opportunities. The value potential of integrating AI, Data and Generative Art, as well as using multi-disciplinary approaches with innovative tools to inspire and catalyse innovative projects can also become a source of resources for education, and ultimately to create positive change!

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Annex 1. A Generative Quotient

VAMOS TOD@S approach can help teams generate huge number of ideas to be explored in their projects. But how “large” is “large”? Here is the formula to calculate a Generative Quotient (VAMOS TOD@S) as a function of the number of combinations possible:

$$GQ_{(V,A,M,O,S)} = \frac{(2^v-1)*(2^a-1)*(2^m-1)*(2^o-1)*(2^s-1)}{(2^5-1)^5} \quad (1)$$

Where the variables in formula (1) represent the number of entities in each V.A.M.O.S. strategy dimension:

- v: # Vision/Value propositions
- a: # Artefacts/Activities, Assets, Architecture elements
- m: # Methods/Models employed
- o: # Organization/Operation entities
- s: # Stakeholders/Systems involved

The denominator in (1) corresponds to a reference “innovative” project with 5 elements in each dimension and thus, a total number of 28.629.151 generated combinatorial ideas as calculated in (2).

$$COMB(5, 5, 5, 5, 5) = (2^5-1)^5 = 28.629.151 \quad (2)$$

This reference (“average”) project is selected based on the author’s ample experience with such types of innovative endeavors in diverse settings.

Therefore, the symbolic $GQ_{VAMOS\ TOD@S}$ value is used as a reference tool to inspire and reflect on the potentials of a project being formulated and as an invitation to generate options for creative value creation.

Annex 2. Chatting with ChatGPT

New tools, new conversations? You may wonder, as myself, and seeing the recent announcement of a beta version of OpenAI’s ChatGPT [16] for research, I decided and tried out this new iteration of OpenAI language models GPT’s on one of the themes of the case-studies, namely the one about “Fallsonancia”. Below is the unedited/complete chat.

Prompts: YB (Yan Bello), CG: ChatGPT.

YB: What is the meaning of *fallsonancia*?

CG: There is no such word as "fallsonancia" in the English language. It may be a misspelling or a made-up word.

YB: What meaning would you attribute to a made-up word such as "fallsonancia"?

CG: It is difficult to attribute a meaning to a made-up word such as "fallsonancia" without context or any additional information. It is possible that the word was created to convey a specific concept or idea, but without any additional information it is impossible to determine its meaning.

YB: The context is about preventing adult people's accidental falls

CG: In this context, "fallsonancia" could be a made-up word that refers to the prevention of accidental falls among adults. It could be used to describe strategies, practices, or tools that are designed to reduce the likelihood of adults falling and experiencing injuries. For example, "fallsonancia measures include installing handrails in staircases

and providing non-slip mats in bathrooms."

YB: Do you relate this made-up term with dissonance?

CG: Dissonance and fallsonancia do not have a direct relationship, as dissonance refers to a lack of harmony or consistency, while fallsonancia is a made-up term that could refer to the prevention of accidental falls. However, it is possible that the person who created the term "fallsonancia" was trying to convey the idea of preventing a discordant or unpleasant outcome, such as an accidental fall. In that sense, there could be a connection between the two concepts.

YB: And would there be any relationship between these terms and sound design, sonification or music?

CG: There is no direct relationship between fallsonancia, sound design, sonification, or music. However, it is possible that the person who created the term "fallsonancia" was trying to convey a concept that is related to sound or music. For example, the term could be used to describe strategies or tools that use sound or music to prevent accidents, such as playing calming music in a public space to reduce the likelihood of people falling. In that sense, there could be some connection between fallsonancia and sound design, sonification, or music.

YB: Or any relationship with generative art?

CG: There is no direct relationship between fallsonancia and generative art. Generative art refers to art that is created

by a system or algorithm, often using computer-generated processes. Fallsonancia, on the other hand, is a made-up term that could refer to the prevention of accidental falls. However, it is possible that the person who created the term "fallsonancia" was trying to convey a concept that is related to generative art, such as using generative algorithms to design safety measures or tools that prevent falls. In that sense, there could be some connection between fallsonancia and generative art.

YB: How would you use art, data and artificial intelligence to promote good causes (such as, for example, in healthcare: preventing adult falls and/or raising awareness about it)?

CG: There are several ways in which art, data, and artificial intelligence could be used to promote good causes, such as preventing adult falls and raising awareness about this issue. Some possible approaches include:

- Using data and AI to identify patterns and trends in the data related to adult falls, and using this information to develop targeted interventions and strategies that aim to prevent falls. For example, AI algorithms could be used to identify common factors that contribute to adult falls, such as the type of flooring, the presence of obstacles, or the time of day, and to develop recommendations or warning messages that could help to prevent falls in these situations.
- Using art and design to create

visualizations or interactive installations that illustrate the impact of adult falls and raise awareness about the importance of preventing them. For example, an installation could use data and AI to create a real-time visual representation of adult falls in a given area, highlighting the number and location of falls, and providing information about the risks and consequences of falls.

- Using AI and machine learning to create personalized or adaptive interventions that aim to prevent adult falls. For example, an AI system could be trained to recognize an individual's risk factors for falls, and to provide tailored advice or support to help them reduce their risk of falling. This could include providing personalized feedback on their daily activities and behavior, and suggesting interventions or strategies that are tailored to their specific needs and circumstances.
- Using AI and data analysis to develop predictive models that can identify individuals who are at high risk of falling, and to provide targeted interventions and support to help them prevent falls. For example, an AI system could be trained to analyze data on individual factors, such as age, gender, medical history, and physical activity levels, and to generate risk scores or alerts that could be used to identify individuals who are at high risk of

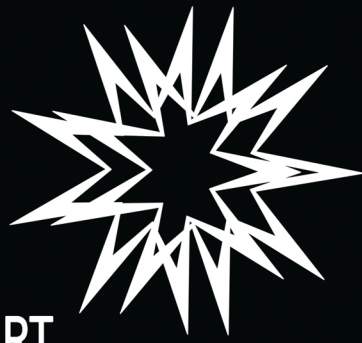
falling and to provide them with support and interventions to reduce their risk.

YB: Do you know about (or have been trained) using Artist.AI website and/or related articles?

CG: I am not familiar with the website or articles related to Artist.AI. I am an AI language model trained to generate human-like text based on the inputs provided to me, but I do not have access to external information or resources.

Notes

The suggestion of ChatGPT including "Using art and design to create visualizations or interactive installations that illustrate the impact of adult falls and raise awareness about the importance of preventing them." Is right on spot and aligned with the NOfall.Art & Artist.AI projects. The last question and answer are indeed an invitation for future work and "agile learning" (for GPT, in this case). To be continue...



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