ICO-Cymatic Backstage Design Process: Applying Vernacular Techniques and New Media Into Ephemeral Spaces for Art Installation in South America

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Abstract
Cymatic is a study area of vibrational nodal phenomena. The term is coined in the field of physics. It refers to the analysis of nodal movements in non-conformal media, such as fluids and grains, generating temporary geometric patterns determined by three significant factors: water volume, light and sound. This research will show some design practices in the form-finding design process in temporal spaces, using geometric concentric patterns obtained from sound stimulation known as cymatic. Stages of recording, analysis and digitization of sound stimulation in volumes of water into small containers with different materials and shapes. The sound registers and its correlation of cymatic phenomena includes traditional building techniques and technological aspects, such as parametric design and 3D printing. Preliminary results illustrate the innovation process on ephemeral space and design objects, considering areas related to art, science and technology. Methodology approaches are mainly based on Research Through Design and it will show some preliminary results about cases of study: Ico-cymatic backstage ; multipurpose ephemeral spaces for art installation. It describes an ephemeral icosahedron shelter built with hybrid vernacular reciprocal structures made with Chilean bamboo and covered by membranes.The following experiments established the causal relationships between sound stimulation and processes of self-organisation of states of matter reflected on surface tension of bodies waters, and it will show this nodal phenomenon as an alternative source of inspiration for design process.

Keywords: Cymatic Patterns, Vernacular Design, New Media, Research Through Design, Temporal Space

Introduction

Geometries and morphology, growth patterns, protection systems, among others geometric factors from nature, have been a fertile source of inspiration for different areas of knowledge. The cymatic movements in their different configurations and media are a fascinating theme, not only for the resulting geometric complexity, but also for making evident a less frequent aspect between the sound and its shape, making visible the invisible. From a physics point of view, a wave is a disruption that moves from the point of origin to the medium surrounding that point. It refers to the effects caused by the periodic movements produced by sound waves, which are reflected in this state of matter. According to Chladni (1787), this phenomenon at the molecular level, electrons generate a compass or cadence creating a variable wave, in which is possible to observe by the human eye be replicated in its organisation characterised by its cyclic geometric movement. In this concern, observation of this sound choreography on liquid state of matter was already part of the studies in the Renaissance, first by Da Vinci and later by Galileo, just to mention a few scholars in the studies of nature that dabbled in this subject. In this regard, cymatic patterns , also known as *standing waves*[11] consists in the interaction of wave parameters of amplitude, frequency and length, which travel by the same medium in opposite directions (nodes and antinodes). CHLADNI, E(1787).

Figure 1: Cymatic pattern obtained from sound stimulation.
Range of frequency from 10 to 200 hertz.
Source: author

[1] Standing wave, also called stationary wave, combination of two waves moving in opposite directions, each having the same amplitude and frequency

Frei Otto coined the term *"Selbstbung"*, which in German describes the process of self-forming. This refers to the generation of the shape of a given structural system under conditions of a "self-encountered" state of equilibrium, defined by the forces acting on it and the internal resistance determined by the material properties. For Otto, just like a soap film possessing the property of self-organisation and thus finding its own shape, a tensioned membrane can be conceived under this same logic, trying to minimise its (material) energy. In other words, Frei Otto determines, by means of the empirical method, what would become a process of self-regulation determined by the physical laws prevailing at that time.

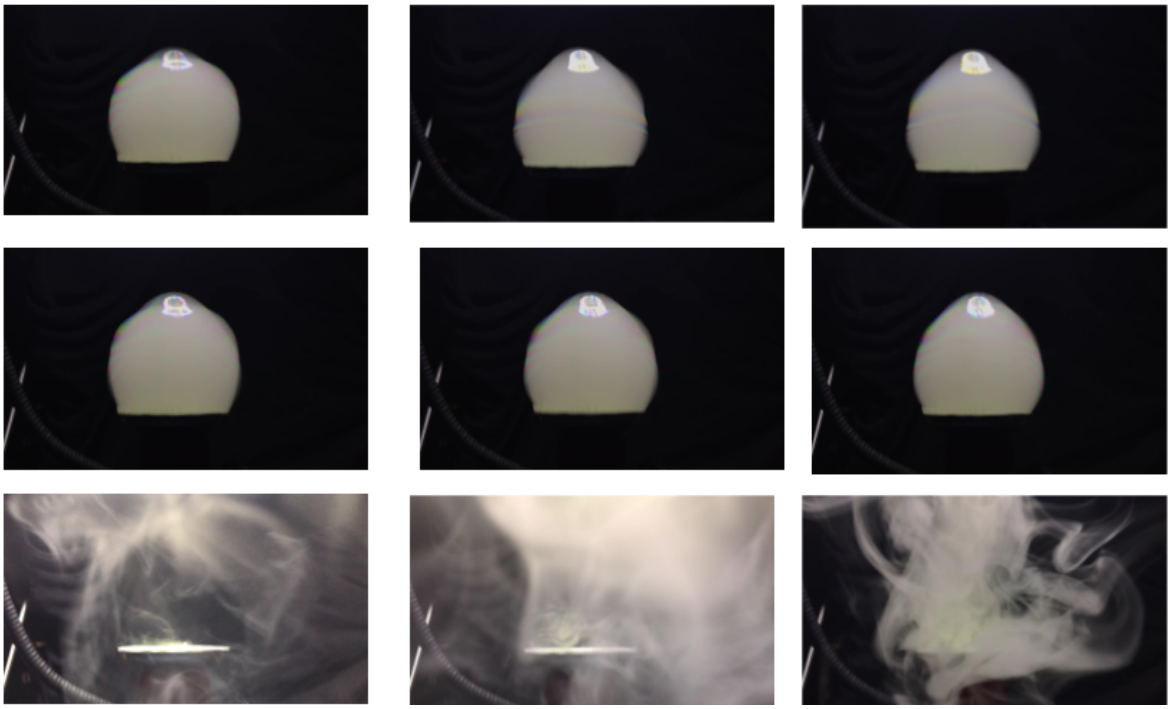

Figure 2: Bubbles soap filled with smoke responding to sound stimulation.
Range of frequency from 5 to 100 hertz.
Source: author

According to GOLDSMITH & FAIA (2014), two main currents can be distinguished in this sense: form finding (FF) and shape finding (SF). An interpretation of these two terms is formed finding and shape finding. In FF, the designer observes processes in nature to discover forms of organisation and methods of construction. The study here is about the ability to discover an optimal form in a context of dynamic adaptability. The beauty of form does not have to be designed; rather it becomes a property that emerges or is discovered. The condition of temporal organisation of the liquid (cymatic patterns) is presented as a new way of interpreting a dynamic surface, which is a potential case study for the observation of surfaces of a certain complexity. Experimentation through artefacts in a controlled environment creates the ad hoc conditions for a case of form finding, in other words a form finding cymatic.

Over time, a large number of experts from the scientific, artistic and therapeutic world have been able to demonstrate the advances in the recording of these patterns and their application in different contexts, making it possible to demonstrate the behaviour of the states of matter and its capacity for self-organisation by means of sound energy, making the invisible visible. The state of the art of this phenomenon is varied, being a reference in some artistic

installations, mapping, print design, object and jewellery design, temporary architecture, or pavilions.

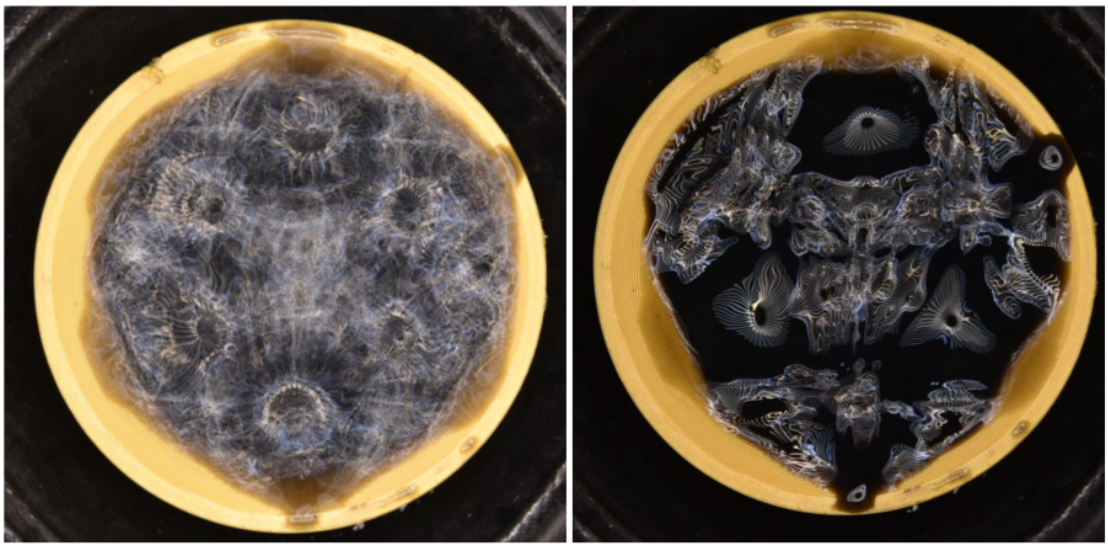

Figure 3 : Cymatic nodal pattern (38 Hetz) . Inked water responding to sound stimulation in circular container Frequency 100 hertz.
Source: author

Material and methodology

The impact of technical procedures has generated changes in how information is processed, generating new behaviours in how information is distributed and shared. Three-Dimensional Scanning, 3D printing systems, laser cutting and engraving, and numerical control centre machines are some of the most accepted technologies in a productive reality on a limited scale and focused on the particular needs of users, who are gradually opting for this type of form to materialise ideas. Open source projects, for instance, are clear evidence about how virtual models and procedures can now be spread throughout the world, which with the help of materialisation technologies, can become a concrete reality.

Technology and parameters

The word parametric derives from the noun parameter, which is a variable in an equation or system. In the field of digital modelling, the term parametric model refers to a digital model based on sets of variables, where the resulting three-dimensional digital shapes or patterns can vary. Changing the numerical value of a single parameter can alter the product of the equation. This means that the final digital result is not completely developed by the designer, but rather the result of an equation, relationship parameters, that the designer-programmer establishes (FERNANDO et al, 2012).

According to CHIARELLA & PASTOR (2015), this renaissance in the conception of complex forms, belonging to the field of Descriptive Geometry, aided by software such as Rhinoceros® and Grasshopper®, provides not only mathematical reasoning in the established parameters, but also a concatenation of ideas and sequence of logical steps described on a virtual canvas. According to the authors, parametric programming offers not only one

solution but a family of solutions to the same problem. Finally, the guiding idea that lies in the incorporation of parameters into design process is fundamentally based on being able to include new instrumental resources that expand the range of possibilities or results in the work of design disciplines CHIARELLA & PASTOR (2015).

On the other hand, CASTRO & PÁSSARO (2017) point out the importance of a reciprocal process between digital and physical models, arguing that it is a constant back-and-forth dialogue between analogous and digital. According to the expert in parametric digital design, the algorithmic relationships created by specialised software for the materialisation of a tangible model are subject to constant improvement processes, thanks to the important feedback generated by observing the behaviour of analogous models devised by computer. Both the virtual and the tangible version are parallel and complementary paths, the differences attend to the aspects of objectivity and subjectivity in the communication process. Digital manufacturing has become an opportunity that this research aims to address, through the use of globalised technologies, material and local techniques, (FRAMPTON, 1981).It is important to mention that at this point the research aims to find parameters that combine the versatility that virtuality brings with it together with the concreteness of the physical world.The following case study presents a method for studying cymatic patterns in its capture, experimentation, synthesis, and interpretation of this natural phenomenon, under certain conditions of light, sound, temperature and density, among other essential factors. The method used by Michael Faraday in 1831 is used as a reference in the first instance, the method used by the scientist to analyse the continuous movement of water using cylindrical containers (SHELDRAKE,M , SHELDRAKE, R.2017).

The first part of the experiment is the design and construction of a sound artefact (Cinemascope, figure 4) to facilitate the observation of cymatic phenomena. In this aspect, even though this cymatic artefact can be built with relatively simple to obtain elements. The main elements of this measuring system are composed of six parts.

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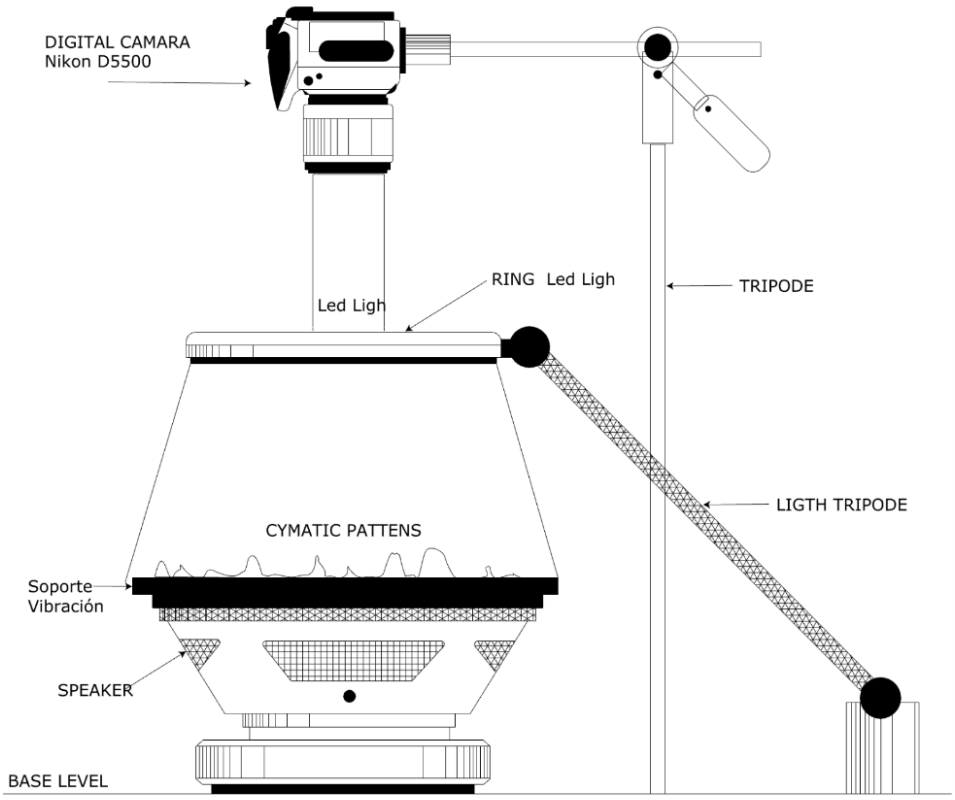

Figure 4: Oscilloscope. Cymatic recording scheme.
Source: author

Components of the system:

-Liquid body: The volume is variable, for this occasion we use a range of 60 to 80 ml of distilled H2O. The liquid is darkened by means of black dye to generate better light contrast on the surface of the volume to be examined.

- Light source: LED light ring inner diameter 80 mm. Total power: 9 W. Colour temperature: 3200 K-5500 K. This type of light source was chosen to allow free adjustment of the recording device, allowing vertical adjustment.

-Recording device: Photographic camera or any media device that allows video and photographic recording. For this experiment, a Nikon D5500 camera was chosen, configured with Iso 2000. The ratio of the ring size is in proportion to the size of the camera lens.

- Support system: Support table for the sound source and liquid container. Independently of this, an adjustable tripod is required to adjust the recording device and the light source. For this experiment, two independent supports were used, so that the distances could be adjusted independently, in order to isolate any variable in the process that could alter the observation of the cymatic phenomenon.

- Sound emulator:
Generator of sound frequencies measured in Hertz. This type of device can be obtained from online digital platforms. In this case, an online sound wave emulator was used in sinusoid or

sine wave mode. Also, there is a MPK *mini* Play mk3 used to generate mainly in ranges between 7 to 100 hertz.

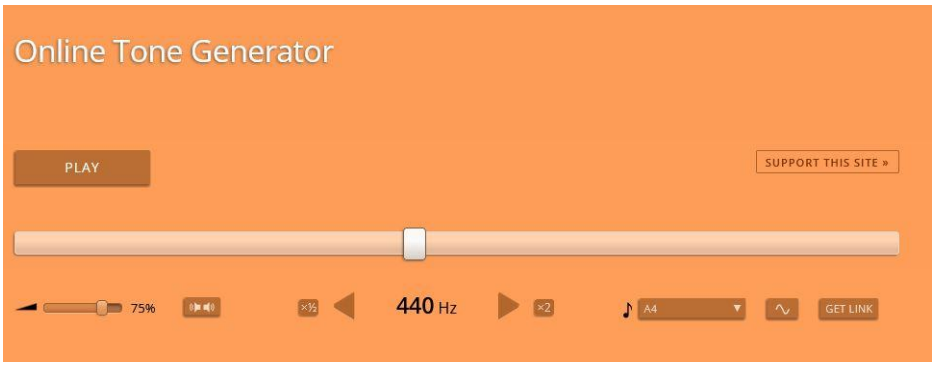

Figure 5: Generator of sound frequencies measured in Hertz.
Source: https://www.szynalski.com/tone-generator/

The methodology used describes research through the design of RtD (Fraylin, 1993) reviewing geometrical aspects of the cymatics and its potential use as an input for the creation of geometric textures based on sound morphology. Our proposal also emphasises on the importance of new media (Manovich, 1993),(CNCA, 2020) for creative processes and morphological studies of three-dimensional patterns generated.

The following case of studies (YIN, R., 2014) will show us the design process based on analogous and digital models inspired by cymatic patterns. its design prospect by using local and global resources in different scales of intervention.

Case of study

ICO-Cymatic Backstage; temporal shelter design space

As FRAMPTON points out in his concept of critical regionalism, local characteristics must coexist with other influences in a symbiotic relationship within the socio-economic and productive sphere. This relationship is enhanced by the contribution of new media and technologies that society has incorporated over time due to globalisation. The different stages of the process of creation, production and dissemination of design are not exempt from these influences. Designers, architects, artists, and artisans, among other creative disciplines, have been retaking forgotten ground, finding an opportunity for local development in cultural dissemination as an essential part of the productive scene, which today is known under the name of the local creative industry. (UNESCO; LOCAL CREATIVE ECONOMY REPORT, 2013).

It seems that this theme of spaces for temporary use is determined by a basic condition of survival in people. The designated attributes in the design of spaces for these situations is a mixed area of knowledge and techniques, where temporary architecture interacts, as well as industrial design, military tactical knowledge, medical assistance, logistics, to name just a few of the professions that work in this area of mitigation of extreme situations.

In the case of tensile structures, we can see an emerging market niche in the implementation of temporary spaces for social and cultural purposes. Regulations for use in urban contexts, structural resistance, quick assembly techniques, forms of high aesthetic value and mainly a

minimum impact on the environment, are some of the considerations that were considered when designing this proposal.

For CORREIA DE MELO (2017), the conjugation among geographical space, people and their respective object-action interrelation, is what finally contributes to the definition of its space, what the author calls as a stage, in this case a stage for temporary or ephemeral use. To go even deeper into this time-use relationship of the time spaces of bounded use, the word refuge refers to a space built to provide temporary shelter or protection. It is in this relationship object - action, that the transitory stay of the traveller who inhabits, spends the night, and recomposes himself physically and psychologically to continue the journey.

Throughout the world, the concept of the vernacular, as a cultural and technical state of popular knowledge, where tangible aspects of ways of living are reflected through objects and built spaces, as well as through the intangible or immaterial, where, for example, the know-how with a certain material on the one hand, or the cadence or intonation of how people speak on the street, further enrich this type of geographic space with vernacular characteristics (SANTOS, M., 2014). To a large extent, this relationship is determined by the place, where its inhabitants, with a resilient posture in the face of the environment and the adversities of nature, have wanted to adapt to the conditions defined by climatic factors and natural resources. In these concerns, another case worthy of analysis is the situation described by the bamboo species, which are scattered in the tropical and subtropical geographical area of the planet, with a range of native and introduced species, forming an important part of the local construction heritage based on bamboo and its properties. . With a fairly wide botanical taxonomy, its natural distribution ranges from 46°N latitude to approximately 47°S latitude, also reaching 4,300 m above sea level. In addition to having a great capacity to absorb carbon dioxide and having a structural resilience comparable to steel, bamboo has a constructive versatility to be complemented with other types of materials, which has been the subject of study and development in the manufacture of structures. resistant and light. . In South America, more specifically in Chilean-Argentine territory, there are other versions of bamboo, the chusquea quila (from the Mapudungun kül̲a; three) and the chusquea culeou, colloquially known as coligüe (from the *Mapudungun*; place of reeds), materials used in the construction of houses, decorative handicrafts, musical instruments, utensils and war weapons of Mapuche origin, as well as objects of daily use in domesticity of Chilean cities. This endogenous South American cane, with few branches, green foliage and daughters with a serrated edge, can reach up to 8 metres in length, and is found from the central zone of Chile, to the extreme Chilean-Argentine Patagonia. The fundamental difference of this raw material in relation to the rest of the bamboo types is that the coligüe has a continuous wall, it is a full cane.

Figure 6: Bambusa vulgaris (common bamboo, Brazil) *chusquea culeou (colihue, Chile).*

Design proposal

Icosahedron cymatic : Multipurpose ephemeral spaces for art installation : It describes an ephemeral icosahedron shelter built with hybrid vernacular reciprocal structures made with chilean bamboo and covered by membranes. Two main uses in terms of arts spaces were part of this design considerations; firly an urban shelter installation developing the concept of cymatic phenomenon. Secondly its capability to transform it into a sustainable art installation that promotes saving water.

It is important to mention that for a reciprocal structure to exist, it needs a minimum of components, being three elements that make possible a three-dimensional version of space, being able to circumscribe regular and irregular polygons at its base, being the reiteration of this pattern of overlapping relationship, as a systemic tessellation, which allows its growth. Finally, each component unit of this system may have different dimensions, but interdependence is a sine qua non-characteristic of this structural support

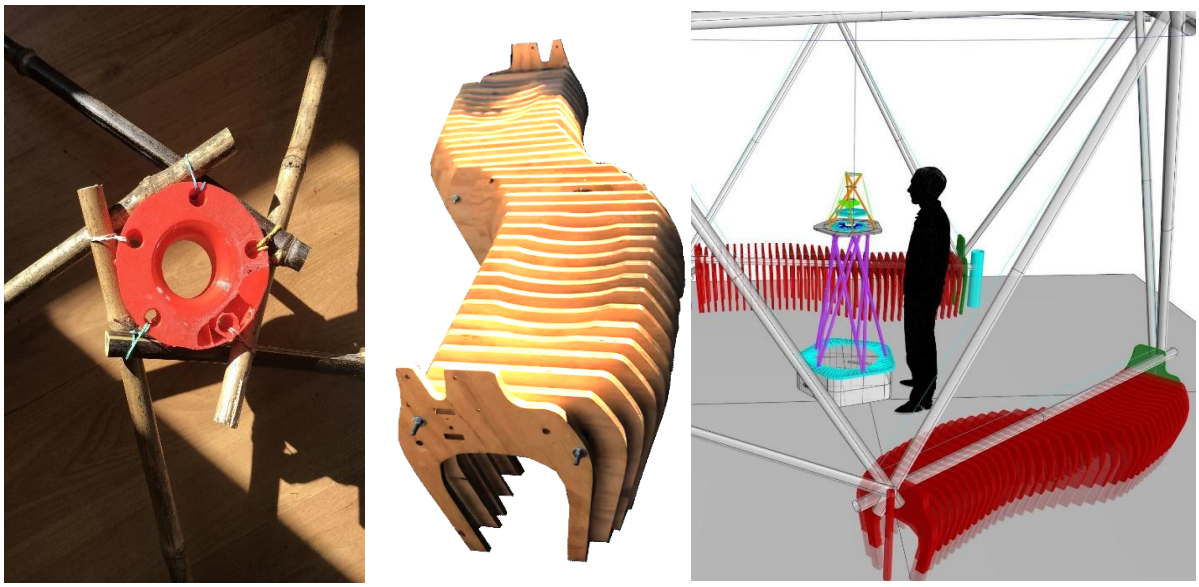

Figure 7, 8 and 9: Design process; icosahedron bamboo connector (PLA printed), Parametric bench and general structure proposal.
Source: author

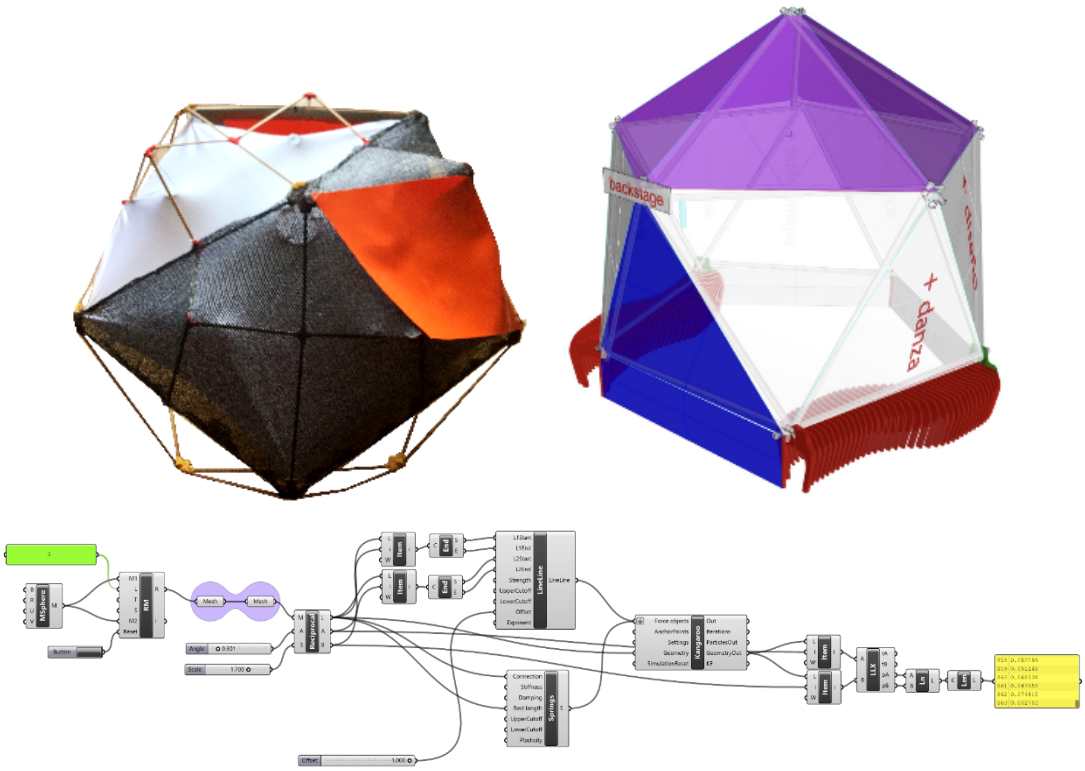

Figure 10, 11 and 12: Physical scale model proposal (1:5); virtual shelter ; workflow for reciprocal structure Grasshopper and Rhinocero.
Source: author

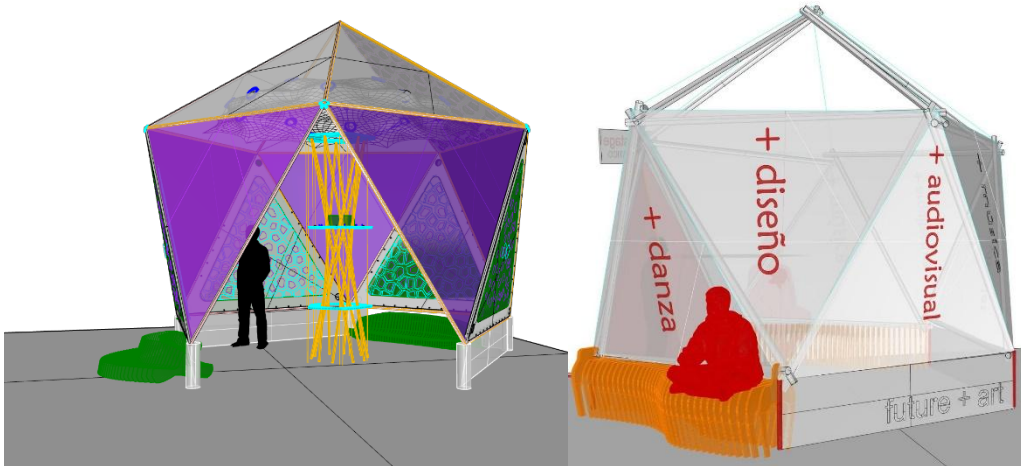

Figure 13 and 14: Virtual design shelter, developing ideas related with a interior mapping projection

This project was part of an art installation, used as a backstage concert nearby BioBio river. Important aspects such as installation process, structure for wind performance and usability will be some of the issues described as part of the result of this interdisciplinary research. This design project was held during the "Music Rivera Festival" in Concepcion Chile in 2020, and it was sponsored by FIC Future Mas/Art: Creative Industry project.

Figure 15 and 16: Oscilloscope and cymatic mapping on roof space.

Conclusion

We believe that the themes underlying this research go beyond the object itself. Iit is also known in the design discipline as discursive design, which is mainly based in the narrative or story that the artefact or object tells, using the design space in order to carry on an important message. The ability to bring something of temporary character or even non-existent to the real world, as part of the ability to relate phenomena and to project new configurations in an advantage that goes beyond the capacity of imagination. On the other hand, The integrated use of tools, techniques and methods is characteristic of a transdisciplinary approach, where knowledge from different areas is integrated into an overall vision, and their relationships and projections can be studied. The result of this methodological approach is characterised by being a state where the contributions of each participant are not identified in isolation; on the contrary, they are merged, achieving another new state. The characteristics of this last method are part of the mode proposed by Jean Piaget in the 1970s, where the type of result or conclusion is a state that does not belong to any of the participating disciplines; it is a new condition, a sort of hybrid state, as a result of the transdisciplinary research crossroads.

We can see that this freedom of choice or free will of digital or analogue methods will bring a series of variables that directly affect the qualitative and quantitative aspects of the research processes. This makes us think of a fruitful field for a conversation between both ways. In the case of the FFC, employing a non-linear thinking process, we have been able to implement different techniques for the capture, processing and materialisation of a complex surface, both for its level of detail and its ephemeral condition. The abovementioned stages make us think of different ways to *"solidify the liquid"*. Either by technological means for its construction or digital visualisation and analogue construction.

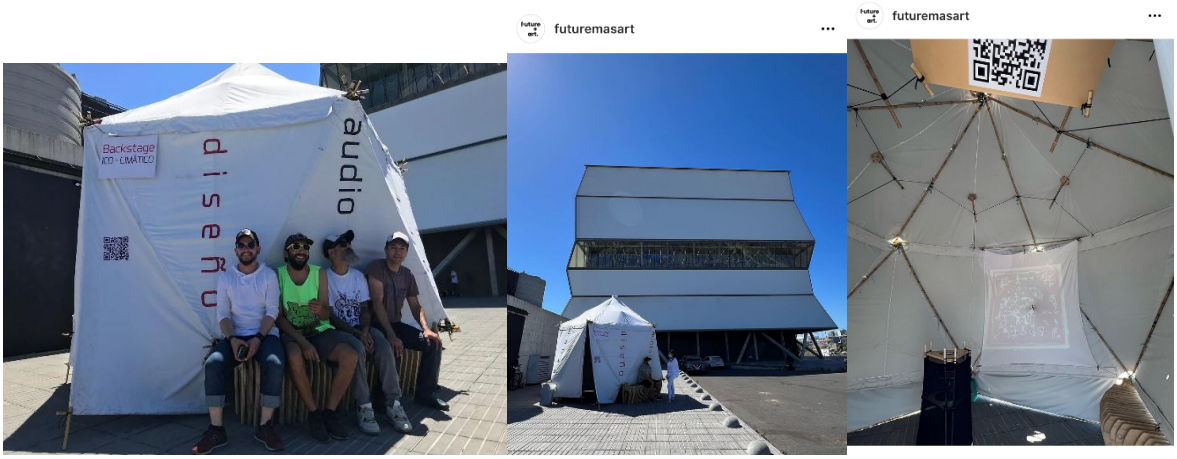

Figure 17 and 18: Social media FIC Future + Art, Inauguration festival day.

Acknowledgment

This project has been part of rigorous work and constant development in new applications in the design of temporary spaces, using as input aspects related to new media and vernacular techniques. The initiative was made possible by Future+ART, Departamento de Extensión, Departamento de Artes y Tecnología del Diseño (DATD- UBB) and Vicerrectoría de Investigación y Postgrado, Universidad del Bío-Bío (VRIP). We must also include different institutions and people who actively participated in this process: Teja Verde Ecodiseño, Johann Bórquez from Creative Centre of Concepción (C3), Alexis Rosas Gavilán from Wai Diseño, Macarena Flores, Alexandra SIlva, Fernando Marín, Paola Albanes from Cotton Confecciones, João Victor Azevedo de Menezes Correia de Melo (PUC- Rio, Brazil) and especially thanks to New Newtonians Group.

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