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Tectonics of Perception
Representation of Atmospheres Through Synesthetic Notation

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Drawing a parallelism with cognitive synesthesia, an automatic phenomenon by which certain individuals experience cross pairings of at least two sensory organs, this essay defines the term *synesthetic notation* as a system of representation by which the rules of two discrete notation systems are voluntary interchanged. An array of students' projects illustrates synesthetic notation as particularly instrumental in the representation of atmospheres. Each project represents one aspect of the environment giving over its experiential condition, privileging instead the dynamic character of the generated artifacts and their transformative capacity in the ability to suggest new alternative realities.

> For indeed "out there" there is no light and no color, there are only electro-magnetic waves; "out there" there is no sound and no music, there are only periodic variations of the air pressure; "out there" there is no heat and no cold, there are only moving molecules with more or less mean kinetic energy. ...Finally, for sure, "out there" there is no pain.
>
> —Heinz von Foerster[1]

In his 1973 essay "On Constructing a Reality," the Austrian-American cognitive scientist Heinz von Foerster outlines a new theory of the tectonics of perception by redefining perception's structure and the assemblies that take part on the cognitive process. He develops the Principle of Undifferentiated Encoding, a critical characteristic of perception that explains how "the environment as we perceive it is our invention."[2] The author defines cognition as the act of computing, an "operation...that transforms, modifies, re-arranges, or orders observed physical entities, *objects*, or their representations, *symbols*."[3] In this model of cognition, our senses act as data processors that generate neuronal impulses, which the brain translates into the images that we understand as the environment. Seen under this light, perception operates as a symbol system where each image corresponds to one item in a field of references producing abstract representations of reality, which, according to Foerster, are reduced versions of what is "out there." Potentially, other interpretations of the "out there" are possible with the same encoded information.

A perceptual phenomenon that occurs during the cognitive process, synesthesia illustrates how different actualizations of the same information embedded in reality are possible. A rare condition by which four percent of the population experience coupled sensations, or cross pairings of at least two sensory organs, synesthesia takes place when a "triggering stimulus evokes the automatic, involuntary […] perception of a sensory […] property that differs from that of the trigger."[4] The stimulus of sound is perceived as the sensation of smell; the stimulus of smell as the sensation of vision; vision as touch; touch as taste, etcetera. "Ordering rules of pairing exist in both, synesthetes and non-synesthetes," but the mere existence of the phenomenon of synesthesia is proof that these perceptual rules can vary.[5] Perception therefore does not exactly reproduce reality, but actualizes it differently through rules of translation that operate like notation systems. In that sense, perception as a creative act constitutes a space where notational rules bring forth realities.

Directly addressing the production of art as an act of "world-making," American philosopher Nelson Goodman describes the allographic arts as those operating through interpretation and on the basis of conventions within symbolic systems.[6] Goodman explains how these arts can be reproduced at a distance from the author by means

of notation. He argues that, since we discover and even create the world we live in by interacting with symbols, our interest in allographic arts is manifestly cognitive. As symbolic representations, allographic arts contribute to our "knowing" of the world.[7] "In these art forms, the abstract schemas of the notation systems precede the tangible form of the work" that is later manifested through interpretation.[8]

In this sense, the tectonics of perception in cognition can be compared with the notation systems in the allographic arts, in that both work as systems of reference where one thing can stand for another, and both translate information through a set of rules that are reductive and abstract. In either case, the rules of translation are deployed in the space between the perceiver and the perceived in a process characterized by the copresence of creativity (world-making) and cognition (world-knowing). Furthermore, each type of information is prone to be translated through a specific sensory organ (in cognition) or a specific art form (in the allographic arts); energetic vibrations of light are typically processed through the organ of the eye, and a music score is conventionally translated into a sounding form of art.

One step beyond Goodman's theory is the notion that through allographic works, the same referent of reality can be apprehended into different art forms. Taking as a case the "golden section," for instance, different manifestations—a work of music, a drawing, a dance piece, or an architectural space—would be possible through different symbolic translations (notation systems) of the information encoded in its mathematical equation.

Drawing a parallelism with the condition of cognitive synesthesia as an involuntary phenomenon by which sensations and sensory organs that are not supposed to go together actually do, it would be possible to define the term *synesthetic notation* as a system of representation in which the rules of two discrete notation systems are voluntary interchanged. If the notion of cognitive synesthesia enables the transposition between sensations—the perception of a bright sound, a warm red, a soft light, etcetera—synesthetic notation enables transpositions between different creative works: a drawn line that produces sound, a music score that is interpreted into an architectural space, or the notation of a dance choreography that is translated into a large-scale sculpture.[9] Great design potential is unleashed when a notation system crosses the boundaries of the art form that is typically confined by convention into another art form or creative manifestation.

These transpositions are possible thanks to the critical role of translation in the process of world-making and world-knowing. The information emitted in the domain of the reality is able to cross into the realm of the perceiver through a set of rules by which an input of information is translated into an output of an image, bridging the gap between the observer and the observed. Through a series of experiments by which we perceive things that are not there or we do not perceive things that are there, Foerster demonstrates how our brain contributes to this process of translation by taking incomplete information from the outside world and making it complete (Figures 1, 2).[10] This phenomenon which has driven much of modern research on the perception of art is what Ernst Gombrich from the Vienna School of art history called the "beholder's share," emphasizing the fact that "art is incomplete without the perceptual and emotional involvement of the viewer" and, therefore, viewing a work of art involves a creative process from the side of the beholder.[11]

Our image of reality, too, is an interplay between the attributes of the perceived object and the beholder's share. This intersecting

Figure 1. *Left:* Gordon Pask, illustration for the article "On Constructing a Reality."

Figure 2. *Bottom:* Heinz Von Foerster, "Blindspot experiment." In the article, "On Constructing a Reality," the experiment is accompanied with the following text:

Hold [Figure 1] next page with your right hand, close your left eye and fixate asterisk of Fig. 1 with your right eye. Move the book slowly back and forth along line of vision until at an appropriate distance, from about 12 to 14 inches, the round black spot disappears. Keeping the asterisk well focused, the spot should remain invisible even if the figure is slowly moved parallel to itself in any direction.

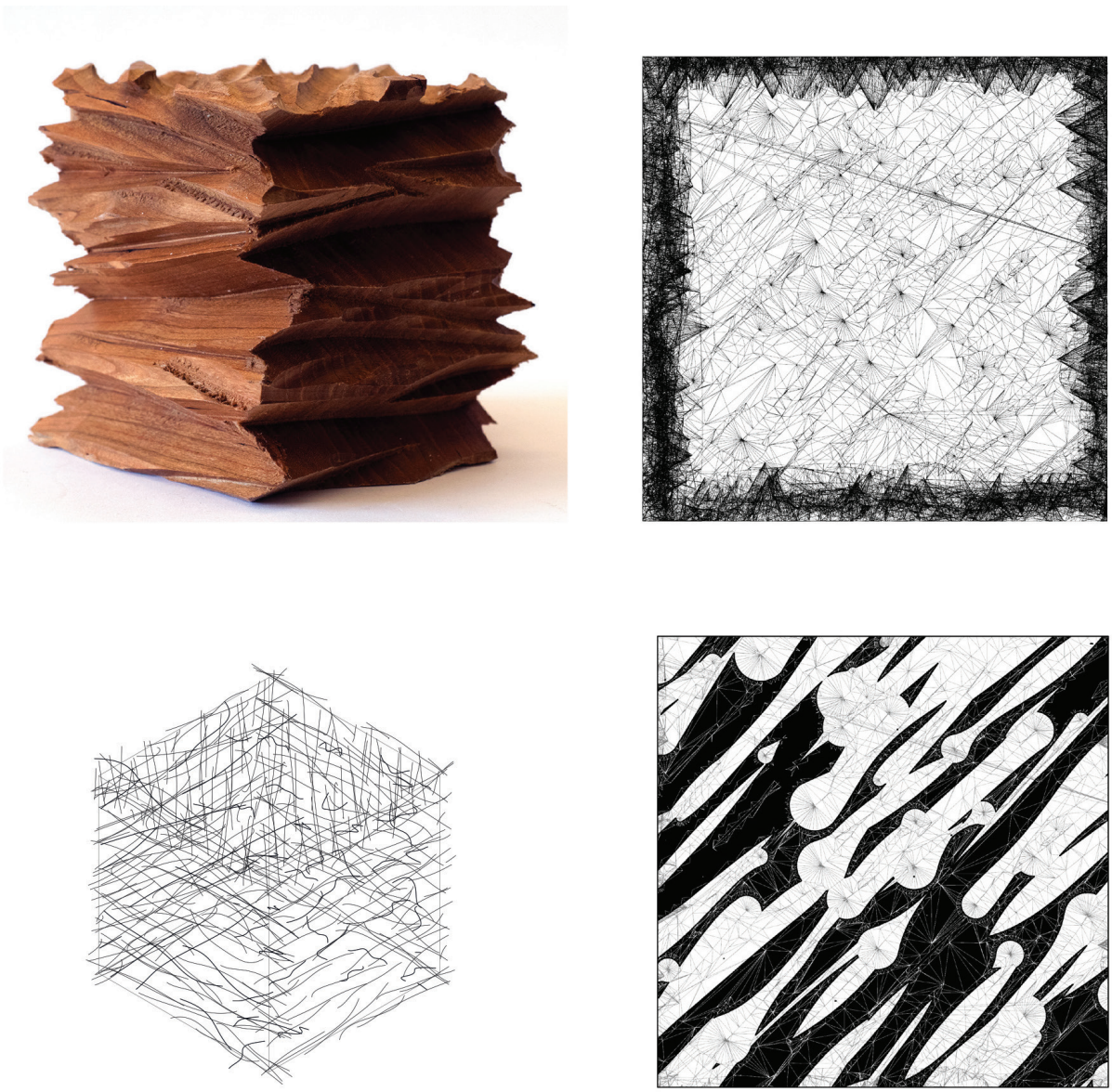


Figure 3. Alexandre Beaudouin-Mackay, Wind Patterns. (Reproduced with permission.)

condition was identified by Gernot Böhme in his 1993 essay "Atmospheres as the Fundamental Concept of a New Aesthetic," when he expressed that this "in-between, through which environmental qualities and human states are related, is atmosphere."[12] According to Böhme, in the production of atmospheres, human states can be better described as "subject dispositions," ways in which we find ourselves "to be positioned to feel."[13] Environmental qualities, he notes, can be better thought of as "object emanations," ways in which the thing perceived "articulates its sphere of presence through its qualities, conceived as ecstasies."[14] Produced and experienced in a collaboration between the "object emanations" and the "subject dispositions," atmospheres are tuned spaces or quasi-objective moods that arise between people and things. Atmospheres suggest a way of relating to the world that emerges as an "indeterminate, spatially diffused quality of feeling encompassing perceiver and perceived."[15] In this regard, Böhme considers synesthesia as one of the elements participating in the perception and generation of atmospheres.

As a fundamental aspect of the tectonics of perception, atmospheres are critical for architecture; neither objective nor subjective, they contribute to the knowing and the making of the environment. Hence, addressing architecture from the point of view of atmospheres means

envisioning possible new ways of perceiving and influencing our relationships to the environment, and discovering new conditions for the representation of these relationships. Since atmospheres are "the shared reality of the perceiver and the perceived," the nature of their representation should emerge from this intermediate space.[16] Revealing the activity of exchange that takes place in the gap between these two worlds is a critical condition of a system of representation that deals with atmospheres.

The challenge rests then, not just in the representation of the intangible effects of the real but, more importantly, in how to represent a thing that only emerges as an exchange between the real and the perceiver. If, as Stan Allen recognizes, *notation* is an appropriate system to represent the intangible effects of the real, *synesthetic notation* can then be identified as instrumental for the representation of atmospheres.[17]

Synesthetic Notation in Pedagogy: Representations of the Environment

In the spring of 2018, I conducted a Design Studio at The School of Architecture and Planning at MIT for Master's Students.[18] The Atacama Desert in South America served as a case study to investigate how mediated and immediate experiences of the environment can become a design enterprise. During the first half of the course each student selected one aspect of the Atacama Desert's environment—geology, landscape, history, culture, archeology, etcetera—and, by extracting its internal logics, produced a series of artifacts through an intermodal system of notation. These mediated artifacts, together with the immediate experience of the environment obtained during a subsequent field trip to Atacama, served as design platforms for a series of architectural speculations developed during the second half of the course. What follows are four kinds of mediated experiences of one aspect of the Atacama environment. The geomorphic forces—natural and man-made—that shape the landscape of the desert are represented here through synesthetic notations.

Wind Patterns

The landscape formations of Atacama are generated largely due to the extreme winds of the desert. Alexandre Beaudouin-Mackay's project extracted data encoded in wind patterns of the desert (speed, direction, temperature, and time of year) and used it as information that could be subject to translation. The student designed a series of rules by which a point in space in Atacama was represented as a 5-inch cherry wood cube and by which each season was assigned a different face of the artifact. Wind speed was then translated to a type of line that defined the tool path of a milling machine. These set of rules were deployed in a sequence of consecutive translations, through an intermodal notation system, producing a variety of artifacts—axons, plans, sections, and models—all of them different tangible expressions that had the same inscribed information of the Atacama winds (Figure 3).

Aquifers

An important geomorphic agent in the landscape of Atacama is the water flow. Valeria Rivera Deneke's project extracted the topographic data of the aquifers in the desert through the image processing of an aerial view (Figure 4). To establish the sequence of consecutive translations, the image was simplified into grayscale and a sampling grid for point selection was imposed. Through a series of notation rules, each point was translated into a circle in which the diameter was indexed to the gray shade. The grey shade was an index of range of depth, which was translated into displacement in plan. Finally, a more complex set of rules was designed through a grasshopper definition that distorted the original sampling grid based on the size and proximity of the circles in plan, assigning different relative heights to each point. The output of this definition was the input to a CNC router that generated a new physical topography. Each of the artifacts generated were different interpretations of the topographical information of the aquifer, based on the original points selected. Other sets of selected points would have generated other topographies, but always in relation to the information of the original aquifer.

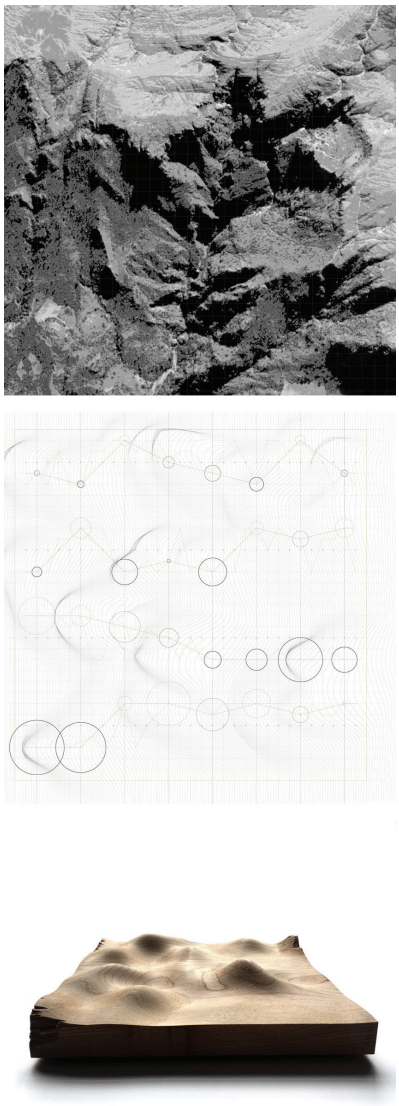


Figure 4. Valeria Rivera Deneke, Aquifers. (Reproduced with permission.)

Figure 5. Valeria Rivera Deneke, Open Pit Copper Mining. (Reproduced with permission.)

Open Pit Copper Mining

As another major geomorphic agent in the desert, copper mining in Atacama leaves profound scars in the landscape. Rivera Deneke studied how the topographies of the open pits change in time by mapping the paths constructed to circulate them at different points in the history of the mines (Figure 5). To trigger the consecutive sequence of translations, each three-dimensional coiled line that resulted from the tracing of the paths was simplified into a single thread of information. These threads were then unrolled, using a reference curve to maintain the critical attributes of the original line in the landscape. The three unrolled curves were then placed in section and lofted, producing a new landscape interpreted from the transformations that the open pit cooper mine experiences through time.

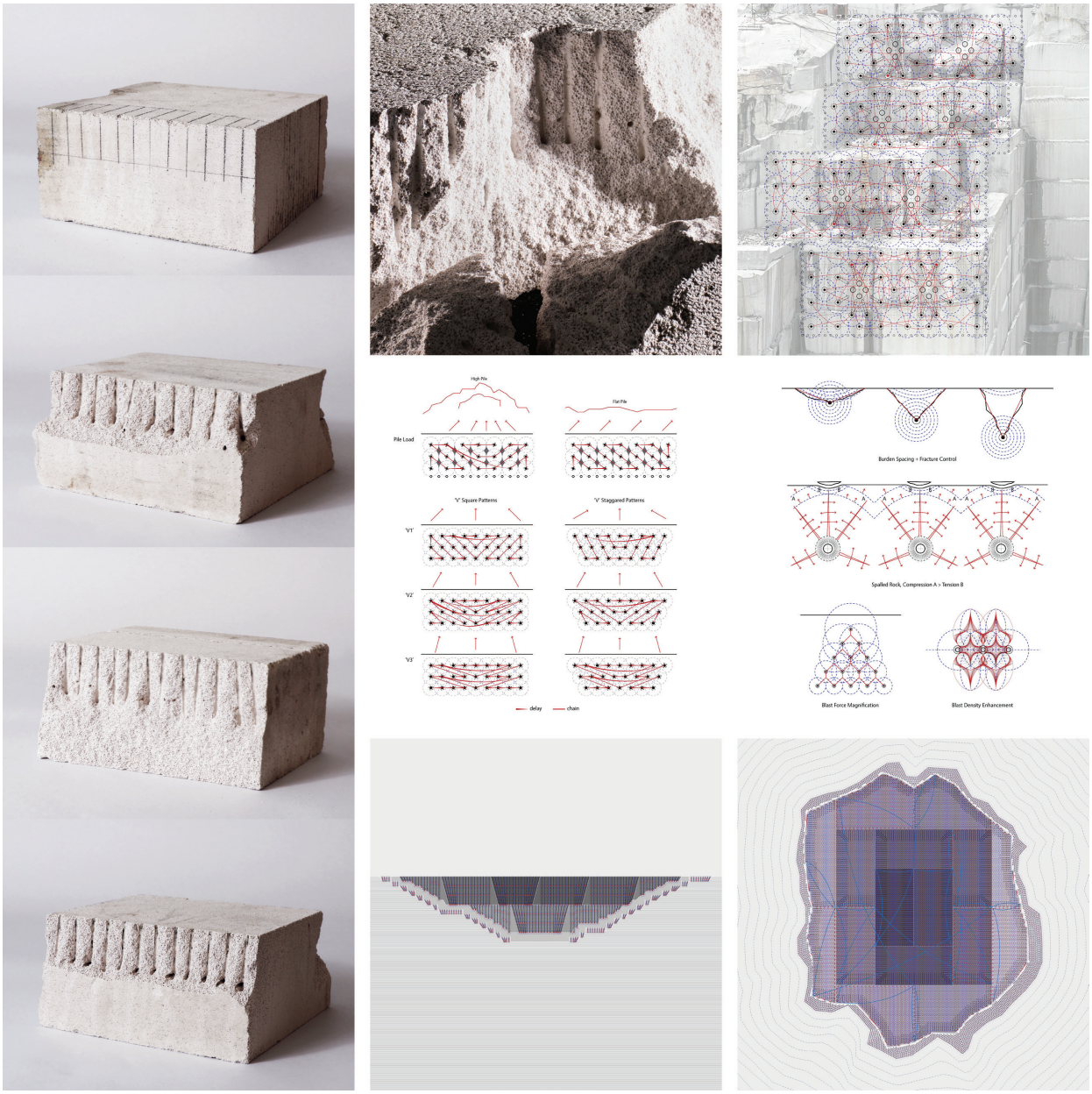


Figure 6. Daniel Joe García, Explosions in Quarries. (Reproduced with permission.)

Explosions in Quarries

Another major geomorphic agent in Atacama are the quarries for rock extraction. Daniel Joe García's project took the event of blasting in quarries (Figure 6). The information that is required to project explosions in quarries was discretized into small parts: the setup of drilling holes (spacing, burden spacing, and size), blast intensity (explosive type and content), sequence and timing (chain for the same time explosion and delay for second chain explosion), angle of blast, and soil composition. Through a notation system, these bits of information were translated into a set of highly precise instructions for the production of specific blasting events whose outcome would have a large degree of both control and unpredictability. In this project, the intermodal component of notation was apparent in its ability to change the direction of operation: these synesthetic notations were representations of projected future blasting events, but also representations of existing physical spaces: current quarries in Atacama generated by explosion detonated in the past (Figure 8).

If, as we have seen, atmospheres are the shared space between the environment and the perceiver; the atmospheric potential of these four synesthetic notation examples—wind patterns, aquifers, open pit

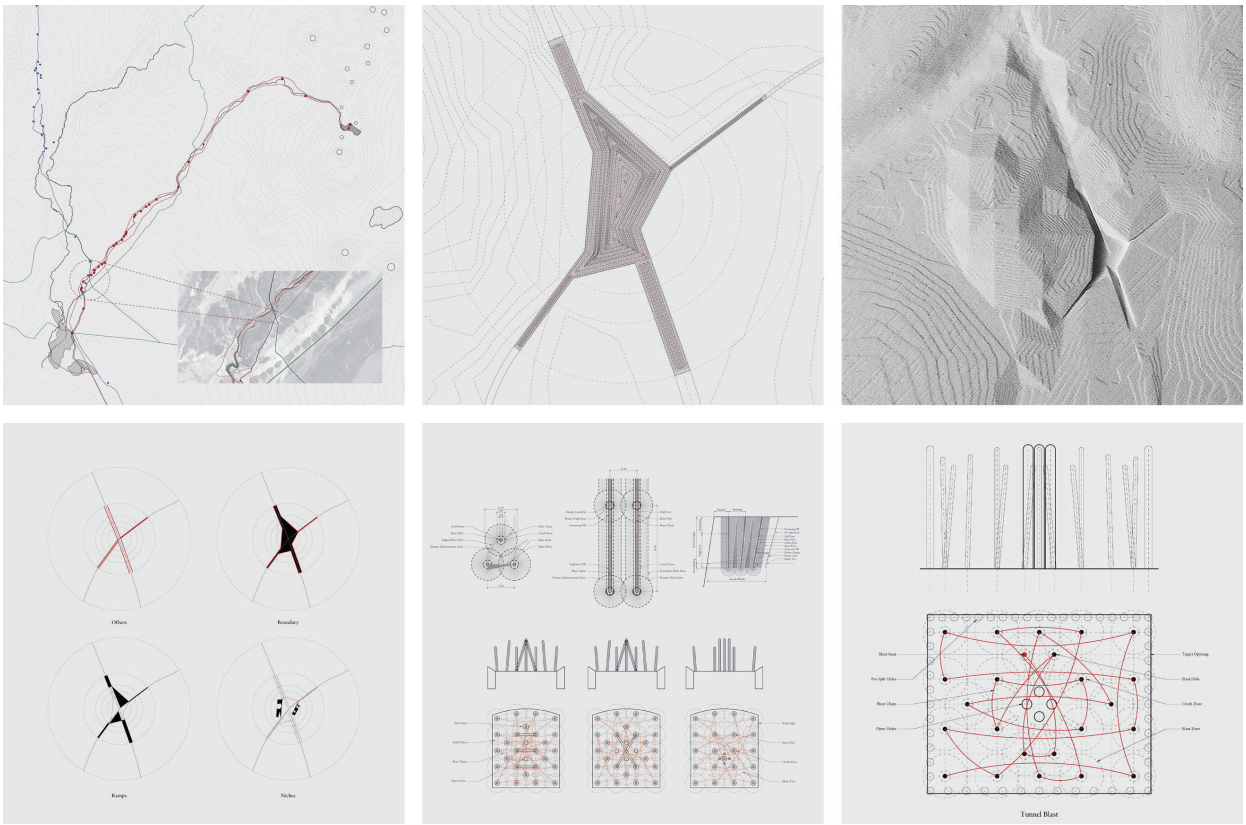
cooper mining and explosions in quarries—is precisely in their ability to imagine that space between both worlds. Rather than representing "subject disposition" or "object emanations," the projects dissect the threshold between both conditions, opening up possible ways in which they can come together. As a method, synesthetic notation renounces the experiential aspect of representation privileging the dynamic character of the generated artifacts. Each of the artifacts produced is a representation of an aspect of this environment and, at the same time, a set of instructions for the production of a different artifact by which the existing realities of the Atacama Desert can be reimagined, manipulated, and transformed. Hence, the artifacts reveal the creative potential of the exchange that takes place in the gap between worlds, becoming instrumental in their transformative capacity. By reimagining the rules that bring forth specific conditions, these synesthetic notations work as material for design and speculation in their ability to allow for new realities.

Figure 7. Daniel Joe García. The project aims to recover pilgrimage trails of different cultures in Atacama. A notation system that was originally designed to communicate blasting events in Atacama was used in this project to design and represent an architectural space in the desert. (Reproduced with permission.)

Synesthetic Notation in Pedagogy: Potentials for Design

Based on these initial studies, the final project asked for the design of an architectural intervention in the Atacama Desert. Students were asked to investigate opportunities for intervention and to calibrate the character of the project, the program, the user, and the specific location of the site. To this end the trip to the desert was instrumental, enabling students to reflect upon the previous exercise, to develop research on site and to embrace the immediate experience of the desert and its atmospheres. The projects sought to foster the material knowledge of these territories, to promote and share the local cultural identity of the place, and to be symbiotically and sensitively attuned to the rhythms of the area. In this respect, the synesthetic notations were critical instruments not only to reveal and represent the logics underlying these landscapes, but also to suggest nondirect methods for the translation of these logics into architectural terms.

As an example, García identified three cultures of three eras that left three different marks on the landscape of the desert. During the study trip, he explored the overlapping of Atacamenian, Incan, and Chilean cultures by mapping the infrastructure of pilgrimage paths in the region (Figure 7). His final project takes a multicultural crossroads of these paths and enhances it by creating a space for interaction in the junction. The project aims to recover these pilgrimage trails and to



share their historical value through an architectural space inserted in their node of intersection. The project takes cues from the carving systems used by the Atacamenian and their way of augmenting the environment to suit their needs with minimal resources. In this respect the synesthetic notations of the quarries suggested an architecture designed with what exists, reduced to essential forms, details, and resources. A notation system that was originally designed to communicate blasting events in Atacama was later used in this project to design and represent an architectural space in the desert. Producing architecture using the logics of the blasting events in a quarry required the ability to relinquish control while embracing unpredictability in the design process. Hence, the plan drawing of the project was the notation system of the projected blasting sequence of events that would generate the space leaving room for the unforeseen.

Through immediate experience and mediated synesthetic notations of atmospheres in the Atacama Desert, the studio fully embraced the notion of tectonics, moving seamlessly across its meanings: tectonics of the crust of the earth —its processes and its evolution through time; tectonics in architecture—its construction methods and technologies; and tectonics of perception—as the creative and cognitive processes by which we, humans, relate to the environment.

Author Biography

Cristina Parreño Alonso is a licensed and award-winning architect who specializes in activating public spaces through architecture and art installations. She currently teaches graduate and undergraduate design studios at MIT School of Architecture and Planning. She was one of the four emerging firms at the "Design Boston Biennial 2015" where she exhibited one of the pieces from her research "Tectonics of Transparency". The project investigates light and transparency as active triggers of new forms of cultural and social exchange within different communities and the environment. In 2017 she was selected by the City of Boston to design a public art intervention in Hyde Square in Jamaica Plain where she will install her project "Glow".

At MIT her research explores material tectonics. Through her work "Transtectonics," she challenges conventional assemblies of materials through unorthodox translations of processes and techniques. By use of antithetical material choices, intentional mismatches, and calculated discrepancies, she works with prototypes and installations that challenge assumed frames of reference and which through improbable pairings of material and tectonics they push towards experimentation and innovation in design.

Notes

1 Heinz von Foerster, "On Constructing a Reality," *Environmental Design Research* 2 (April 1973): 35–46.
2 Ibid.
3 Ibid.
4 Richard E. Cytowic, *Synesthesia* (Cambridge, MA: MIT Press Essential Knowledge Series, 2018), 3.
5 Ibid.
6 Nelson Goodman, *Languages of Art: An Approach to a Theory of Symbols* (Indianapolis: Bobbs-Merrill Company, Inc, 1968), 154–57.
7 Goodmad discusses the idea of knowing "as a processing of raw material received from the senses, and of this raw material as being discoverable...by methodical disinterpretation." Ibid., 8.
8 Stan Allen, "Notations and Diagrams: Mapping the Intangible," in *Practice: Architecture, Technique, and Representation* (New York: Routledge, 2009), 40–70.
9 In 1977, the artist and composer Iannis Xenakis created the UPIC, a digitizing tablet that connected to a computer, allowing him to effectively "draw" music through synesthetic notation. See Gérard Marino, Marie-Hélène Serra, and Jean-Michel Raczinski, "The UPIC System: Origins and Innovations," *Perspectives of New Music* 31, no. 1 (Winter, 1993): 258–69. Regarding the relationship between music and architecture, Charles Jencks notes that "since at least the sixth century BC, music and architecture have been intimately joined by a cosmic connection, the idea that they both are generated by an underlying code, an order revealed by mathematics and geometry." See Jenks, "Architecture Becomes Music," *Architectural Review*, May 2013, https://www.architectural-review.com/essays/viewpoints/architecture-becomes-music/8647050.article (accessed 30 October 2018).
10 Foerster carried out several experiments in order to test his theory. "Blindspot," for example, demonstrates a localized blindness in our field of vision.
11 Eric R. Kandel, *Reductionism in Art and Brain Science: Bridging the Two Cultures* (NY: Columbia University Press, 2016), 17–23.
12 Gernot Böhme, *Atmospheric Architectures: The Aesthetics of Felt Spaces* (NY: Bloomsbury, 2017), 14.
13 Ibid., 90.
14 Ibid., 23.
15 Ibid., 1.
16 Ibid., 23.
17 Allen, "Notations and Diagrams."
18 This design studio is the second of a series called Igneous Tectonics, taught at MIT during the fall 2017 and spring 2018 by Cristina Parreño in collaboration with Sergio Araya, dean of the Design Lab at the University Adolfo Ibañez (Santiago, Chile). The studios were funded by a MISTI Chile Grant as part of a research project that explores new possibilities for constructing with volcanic rock. The first studio, which took place in the volcanic landscape of Villarrica in Chile, proposed to go about this goal by developing a series of material experiments, producing unexpected combinations of volcanic rock with other materials like glass and aluminum. The second studio, in the Atacama Desert, aimed to expand the use of volcanic rock, producing architectural projects at a larger scale in Atacama's volcanic landscapes. The studio was divided in two parts: Part One/Diagraming: work of analysis of the Atacama Desert, and Part Two/Project: design of an architectural proposal with site and program. This essay draws on some of the projects produced only during Part One/Diagramming, and only insofar as they are illustrations of synesthetic notation, which the author defines in response to her own research and personal disciplinary preoccupations that relate architecture to our system of perception, art, and neuroscience. Only a brief insight of one project developed during Part Two/Project appears in the article to demonstrate the instrumentality of synesthetic notation for the production of an architectural project.