

# Systems Thinking and Environmental Interaction in the Work of Tomás Saraceno and David Dunn

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## ABSTRACT

*This paper explores the use of art and music in the work of Tomás Saraceno and David Dunn. Using technology, both artists interact and communicate with nature, creating work that comments on our relationship to the environment. I examine the theories and aesthetics of systems thinking to give background into the approaches of Saraceno and Dunn, who were influenced by thinkers Fritjof Capra, Humberto Maturana, Francisco Varela, Jack Burnham, and Iannis Xenakis. I also use Jennie Gottschalk's experimental music history to situate Dunn's work with other experimental music of the time and relate Gottschalk's ideas to Saraceno's work. Then, I consider how Saraceno's *14 Billions* and Dunn's *The Sound of Light in Trees* represent systems thinking. Lastly, I discuss the aesthetics of interaction with nature, including interspecies communication, that these works bring up.*

## 1. INTRODUCTION

Tomás Saraceno and David Dunn use art and music to explore our relationship to the environment. They seek to interact and communicate with the environment, utilizing technology, to imagine a new way of relating to nature<sup>1</sup> that is more sustainable and interconnected. To understand the conceptual characteristics of their work, we must consider the history of systems thinking (see section 2). The categories of experimental music formulated by Jennie Gottschalk help to locate Dunn in experimental music history; they can also be applied to Saraceno's work. Saraceno's *14 Billions* and Dunn's *The Sound of Light in Trees* are two works that exemplify this interaction with nature and deep understanding of interspecies communication.

## 2. A HISTORY OF SYSTEMS THINKING

Systems theory emphasizes holism over reductionism, organism over mechanism and process over product. In contrast to traditional western scientific approaches to knowledge, it shifts attention from the absolute qualities of

individual parts and addresses the organization of the whole in more relativistic terms, as a dynamic process of interaction among constituent elements [2].

Systems thinking, in contrast to systems theory, is a term used by Edward A. Shanken to refer more generally to the related epistemological frame or mindset [2]. The term is used to allow art into the traditionally scientific definition of systems theory. Therefore, the term systems thinking is used primarily throughout this paper.

The conceptual ideas of Dunn and Saraceno have their roots in systems thinking, which proposes an alternative to traditional western teachings. Systems thinking sees the world as a connected system that is kept in a state of equilibrium through feedback loops. Fritjof Capra, Viennaborn physicist and systems theorist [3], writes of the need for a paradigm shift in scientific knowledge that could handle the issues of our modern world in a way that quantum physics and traditional western thought could not. He proposes a new paradigm, ecological awareness, which “recognizes the fundamental interdependence of all phenomena and the embeddedness of individuals in societies in the cyclical process of nature [4].” He sees systems theory as the closest scientific theory to ecological awareness because “the theory provides a common framework and language for biology, psychology, medicine, economics, ecology and many other sciences, a framework in which the so urgently needed ecological perspective is explicitly manifest [4].” One of the central concepts Capra sees in systems thinking that relates to ecology is the theory of self-organizing systems. These are systems where order is not imposed from outside, but from within the system itself [4].

Biologists Humberto Maturana and Francisco Varela are known for adding the theory of autopoiesis to systems thinking. Autopoiesis is an organizational pattern common between living things that makes them self-produce. This idea has had a large impact on Dunn's ability to see everything as interconnected and is used as a formal model in *Threshold and Fragile States* (2010-11) [5]. Similar to autopoiesis is Gregory Bateson's theory of ecology of mind, which states that everything in the environment forms a network with mind-like capacities comparable to thought [1].

By the 1960s, systems thinking had entered the art world. In 1968, Jack Burnham's *Systems Aesthetics* was published in *Artforum*, helping to describe many postformal works being created at that time. As cybernetic thinking was a paradigm shift in science, Burnham claims that a paradigm shift also happened in the art world, with many artists un-

<sup>1</sup> This paper uses Gregory Bateson's conception of nature; of the environment which forms a network of relationships that have a mind-like capacity comparable to thought[1].

dergoing a conceptual move from abstract and minimalist art into systems art. Burnham writes, “We are now in transition from an *object-oriented* to a *systems-oriented* culture. Here change emanates, not from the *things* but *the way things are done* [6].” In art and music, what became more important was the concept behind a work rather than its methods of construction. Burnham denies the existence of any *-ism* or style predominating systems art. Rather, systems art describes a new way of making art that is a response to a modern society and recognizes the “ongoing relationships between organic and non-organic systems, be these neighborhoods, industrial complexes, farms, transportation systems, information centers, recreation centers, or any of the other matrixes of human activity [6].”

Iannis Xenakis was one of the first composers to use the ideas of systems thinking in an artistic practice. In the same way that Capra saw a shift to systems thinking in science, and Burnham in art, Xenakis saw a separation between deterministic western music and the music of the 20th century, which incorporated chance and chaotic elements of nature. Systems thinking provided a more complex version of causality to drive music composition. Ecological systems are complex, self-organizing and autopoietic; musical systems can be the same. Xenakis’ name for this idea is Stochastic Music—a replacement of musical causality and an introduction of indeterminacy. He saw this stochastic process used to make sound as reflecting the processes that happen in nature, such as “the collision of hail or rain with hard surfaces, or the song of cicadas in a summer field [7].”

Jennie Gottschalk has broken down the features of experimental music from the 1970s to include indeterminacy, non-subjectivity, and research. These concepts are ways of exploring the ideas of systems thinking, and its relationship to nature, through music. Indeterminacy, as first used by John Cage, is an act the outcome of which is unknown and is present in some way in most experimental music since 1970 [8]. Dunn’s main method for introducing indeterminacy is through interaction with and imitation of nature. He often uses technology as an intermediary to this interaction. Most recently, Dunn has created circuits that imitate chaotic functions in nature as a way of exploring complexity.

Non-subjectivity is the will of the composer to take his ego out of the creative process. This can be done through indeterminacy or other means [8]. For many composers, including Dunn, this is important because taking the self out of creativity is an act that brings the focus away from the human, leading to Capra’s ecological awareness.

Many composers started not only to incorporate research as part of their processes, but also to see their work as research, not unlike the work of a scientist [8]. The integration of research changes the meaning of the term ‘experimental’ to mean ‘speculative research through composing.’ Much of Dunn’s research focuses on animal and nature communication through sound. His works reveal something we could not perceive previously. For example, in *The Sound of Light in Trees*, Dunn makes audible the vibrations of invasive beetles that have taken up a home in endangered trees.

### 3. TOMÁS SARACENO

Saraceno’s and Dunn’s work reflect the previously discussed philosophical and aesthetic ideas. Since 2007, Saraceno’s artistic process has included researching and interacting with spiders. He interacts with multiple species of spiders as they create *hybrid webs* (Figure 1). After a unique scanning process, he reproduces the webs on a large scale, taking up whole rooms. With these installations, audiences can explore the webs’ emergent connections and imagine new ways of communication and living with the environment. An impetus for his interest in working with spiders was learning of a metaphor used by scientists: the universe as a cosmic web. Spider webs are obvious parallels of this metaphor here on earth [9].



Figure 1. spiders’ hybrid web [10].

Working with nature in this way brings up issues of “other-than-human aesthetics” and makes one question what it means to co-author with another species [9]. Saraceno considers this question through his many works including spider webs and sculptures influenced by weaving. Of primary interest to this paper is *14 Billions* (2010), though other spider-influenced work includes *Galaxies forming along filaments like droplets on a spider’s web* (2009) and *Arachnid Orchestra* (2015). Unique to Saraceno’s work is his use of hybrid webs, which he reproduces to examine how the spiders wove particular structures to interact with other species of spiders.

Saraceno and his assistants used their own aesthetic judgments while weaving the webs, deciding when to combine specific species and when a web is finished. These decisions come from years of research and interaction with the spiders. With hybrid webs they are combining two species, going further from what is natural. This begs the question, is controlling the actions of the spiders to shape aesthetics showing dominion over them or is it a true interaction?

Saraceno and his team had to develop a new method of scanning because the diameter of the spiders’ webs is so fine. Readymade technology could not suffice. In collaboration with the Photogrammetry Institute at the Technical University in Darmstadt, Saraceno devised a photogrammetry method to capture the webs. The spiders spun their webs in a clear box and then Saraceno’s team scanned them using this new method. The process of creating a physical model of this web, which was made from black elastic cords attached to the walls that visitors could walk in and

around, became the *14 Billions* installation (Figure 2).<sup>2</sup>

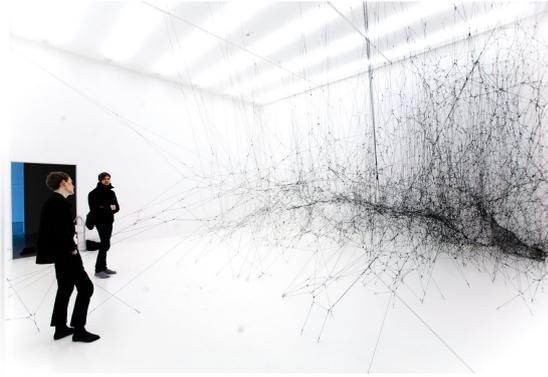


Figure 2. *14 Billions* Installation [11].

Saraceno states that a goal of web scanning is to “understand the emerging properties or patterns or geometries of how these spider’s webs are built, over time, and in space [12].” Webs are a type of self-organizing system written about by Capra. An intelligence emerges out of these systems that can only be explored by looking at them as a whole. Saraceno explained, “This research is not just about planning better ways to hang bridges, but also about understanding the expansiveness and structure of the whole universe. Likewise, to experience these webs down here on Earth might lead to something out there, something that might be interconnected in ways we might not otherwise understand [12].”

With his installations, Saraceno explores a speculative future where everyone can become more aware of each other, humans to humans and humans to nature. Related to his work with spiders, Saraceno took the metaphor of the web as a connecting force and created *On Space Time Foam* (2012). In this installation, visitors walked on large pieces of translucent plastic suspended in space. Because of the construction, they could feel the movement of the other visitors around them, creating a shared space much larger than what one is used to. The installation created a metaphor for social webs of human interaction, even though no actual webs were involved [12].

Saraceno came to an interesting finding about communication from his study of spiders, who are deaf, but have sensitive vibrational sensing techniques. He speculates that the communication method of spiders, interpreting vibrations on their webs, might be an improvement from the way humans communicate. This finding also supports Dunn’s assertion that non-linguistic sound is the best way of communicating because of its abilities to travel between species.

#### 4. DAVID DUNN

*The Sound of Light in Trees* (2006) is a fixed media composition by Dunn, which explores this idea of sound-based interspecies communication [13]. All the recordings making up the work are from the interior of the Two-Needle Pinion Conifer Pine. Dunn recorded the sounds made by different species of beetles that invaded the trees, including the Engraver Beetle and Bark Beetle.

To Dunn, the sound of one species of tree represents the sound of all trees. The listener is meant to reflect on the environment in general, even though the species on the recording is specific. Through listening to *The Sound of Light in Trees* we can “become much more aware of their true interrelationship and diversity within their arboreal environment [13].” This awareness is the ecological awareness that Capra speaks of and relates to Saraceno’s goal of encouraging human-to-human and human-to-nature awareness.

The composition, through a collage technique of layering, grants us the ability to hear a compressed version of the tree’s sound [13]. The arrangement of the recordings allows the interaction of the sounds over time to be appreciated more than if they were just heard one by one in a more scientific setting. If the sounds of the work, the chirping and clicking of the beetles, were treated acoustically, the work would still be a success, but would not have the same unique conceptual qualities granted to it through involvement in research. Unlike the stochastic processes of Xenakis, *The Sound of Light in Trees* derives its form directly from nature, not mathematical processes meant to model nature.

If we compare the methods of interaction with nature of Saraceno and Dunn, we see that Dunn takes a more observational approach. He lets the beetles make sound with no human intervention. Later in the process he takes the recordings and uses aesthetic judgement. Conversely, Saraceno lets his aesthetic judgements shape the hybrid webs as they are being woven.

At first listen, *The Sound of Light in Trees* can be compared to John Cage’s *Child of Tree* (1975) and *Branches* (1976), two works that used the *I Ching* to drive indeterminate operations [14]. In this series of works, Cage has the performer playing plants arranged on stage, treating them as percussion instruments. While the result might sound similar, the concept is different. Cage used a human performer to activate the sound of natural objects, while Dunn lets nature sound itself.

In an interview with Michael Lampert, Dunn referenced the comparison to Cage. On experimental music being like research Dunn says:

What I specifically mean by the term “experimental music” is similar to what experimental refers to in the scientific sense. I’m not making a claim for “doing” science, but I am making a claim for the relevancy of certain activities within the domain of an experiential exploration of sound and consciousness from a transdisciplinary perspective. What I see as experimental is that I’m actually trying to create experimental situations, the outcomes of which are uncertain [15].

Dunn expresses that this research element makes his music different from Cage’s indeterminacy, where controlled systems are setup to yield an unpredictable result. For Dunn, the outcome of the interaction that has been setup with the environment is the most important part. The process of coming to that result ties it to nature and biological processes in a way that separates it from Cage’s concept.

<sup>2</sup> Exhibition at Bonniers Konsthall, Stockholm, Sweden 2010

Dunn's interest in studying the pines came from the knowledge they were dying after being infested by the bark beetle, starting from a less poetic place than Saraceno's galaxies metaphor. Using Bateson's concept of ecology of mind to frame the problem, Dunn saw that Bark Beetles had fallen out of homeostasis with the ecosystem because of climate change and are now causing problems that can't be self-regulated. Because Bark Beetles sense their environment through sound perception and vibrations, sound can be used to determine an ecological problem. These vibrations are inaudible to humans but can be revealed using recording technology through attaching vibration transducers to the bark of the trees.

Dunn compared the acoustic signatures of different trees to measure their level of beetle infestation. Like Saraceno's scanning of the spider webs, Dunn's alternative perspective allowed him to discover a new angle of research. Their goals with both artistic projects were to understand emerging properties in nature that were not already apparent.

Dunn hypothesizes that there is a much more detailed network of interrelationships occurring between the beetles, trees, and fungi. He comes to this hypothesis through years of study in systems thinking and through Bateson's ecology of mind. Dunn is interested in "understanding a sound *and* its context as part of a purposeful, living system with attributes of mind [15]." He sees sound as playing a part in regulating these systems.

Dunn, like Saraceno, admits to his lack of scientific credentials, which means his hypotheses might not be taken seriously, but believes it important for the artist to take a role as a researcher to bring a unique perspective to science. Artists are often better than scientists at engaging in imaginative thinking that can lead to new discoveries. He admits that his work is not useful science on its own and only becomes useful in collaboration with scientists.

## 5. CONCLUSION

Saraceno's *14 Billions* and Dunn's *The Sound of Light in Trees* are works of art that not only entertain, but through collaboration with scientists, seek to further our knowledge of interconnection to our world and engender a sense of ecological awareness. Today, we feel more disconnected from nature than ever before. The results of which can be seen in continued species loss and climate change. We need artists and researchers like Saraceno and Dunn to make the speculative leaps in thinking that can be difficult for scientists, and to communicate their findings in a way that can be enjoyed by the public.

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