David Dunn is a treasure. I know it, and a number of people in the world of music, mathematics, acoustic ecology, and new media know it, but gradually, that knowledge is becoming more widely spread. His intellectual rigor, his refusal to repeat himself, his questioning mind, unfettered by the limitations of any one discipline or another, all place him in the top rank of thinkers today. But there's another aspect of his talent that, with all the emphasis on ideas, interaction, and music's use in the world, tends to not be mentioned—his colossal musical talent, and his exquisite sense of sound—what in the world of composers is generally called his "ear." David has one of the finest "ears" of any composer I know. And he often expresses that "ear" with cutting-edge processes and ideas. On this CD, we have four new compositions by David, all for electronic sound makers of one sort or another, and all four reveal his innate musicality. These are works that live between the arts and the sciences, coming from David's lifelong involvement with interdisciplinary ideas. Indeed, David has on more than one occasion written about "music's insufficiency as a discipline," and by this he means that if one confines one's thinking to just the materials of music, and not with what those materials might come to mean in a larger world, then one is indeed getting much less than half the story. Statements such as this tend to deflect people's attention away from a very simple, perhaps almost trivial fact—a fact that forms the ground for Dunn's ability to start from music and move out to realms of chaos science, acoustic ecology, bio-acoustics, compositional linguistics, and half-a-dozen other fields. That trivial fact: Everything he does is grounded in his solid and deep musicality.

A case in point is *Lorenz*, the first work on this CD. It's a collaboration between Dunn and chaos scientist James Crutchfield, and is part of a sound-and-light piece of theirs called *The Theatre of Pattern Formation.* In this piece, Crutchfield's program for exploring chaos equations, MODE, is linked through an interface program called OSC into a sound synthesis program. The sound synthesis program feeds information back through OSC into MODE, so the whole thing is not only a use of chaos to control sound—it's a feedback loop itself, embodying the principles of chaos not only in its mathematics, but also in its very structure. But what I would like to draw your attention to in this piece is its sound. It roars, it whines, it surges, it pulses, it flies around in stereo space, plunging suddenly now this way, now that, turning on a dime, and leaving you gasping for breath as it zooms away into the distance, only to come emphatically charging back a millisecond later. Notice my description above—"linked through an interface . . . into a sound synthesis program." This is typical of the way Dunn's musical talent is underplayed, even by his friends and supporters. It may be that in the early twenty-first century we assume competence with "sound synthesis programs" as part of a composer's toolkit—just as in earlier eras a familiarity with modulation and fugue was assumed. But don't be fooled—in the ranks of electronic musicians, Dunn is a master. The "patch" he has made here is no ordinary oscillator-filter-amplifier chain, but a complex self-regulating and self-modulating beast that even without MODE's input would be producing complex and gorgeous results. When combined with MODE's chaotic output, and placed into a feedback loop, the result is a machine to explore the visual and sonic "phase-space" of chaotic equations—a spaceship, if you will, to sail between mathematical galaxies of sound and light. Flying that spaceship is Captain Dunn, your guide to the chaotic universe's strange and wondrous entities. It's a thrilling journey, and you can relax—you're in good hands—your pilot is one of the best.

Of course, there are the obvious things to notice here. Dunn is clearly in love with the "analog" sound of early electronic music synthesis. The luscious filtering, phasing, and spreading-out-a-gorgeous-bed-of-sound that is found in almost any commercial synthesizer "pad" timbre is definitely absent here. Instead we have the raw sound of electronic waveforms as they come out of the complex of intermodulating tone generators. In the world of electronic music today, to use such raw waveforms is generally regarded as a "retro" gesture, so obsessed with tone-color fashions has that world become. But that point of view comes from regarding the tone-generator as merely a tool—the composer tells it what pitches to play, and it plays what is specified. Dunn is doing something more interesting here. He is setting up a complex of oscillators and mathematical equations into a self-regulating system—one that he then steers with the reflexes of a racing car driver—and is letting us hear the results of the inner-workings of that system, with both unadorned electronic timbres and a very quirky set of scales produced by the kinds of modulations

he uses. Surely an invitation such as that is worth responding to.

In *Lorenz*, Dunn steers us through the universe of one chaotic equation, the Lorenz attractor. Want to see/hear another example of the Lorenz equation in action? Look out your window. It's used to model certain aspects of the weather. In *Nine Strange Attractors*, Dunn guides us through a whole zoo of chaotic attractions. The names of the beasts? Duffing, Lorenz, nScroll, Owl, Pendulum, ProtoLorenz4, Rikitake, Rossler, and Van der Pol. Each one has different behaviour, and each produces a different sound world. It's a wild mercurial ride. But for those who understand classical music—there's another level here—this piece is a twenty-first-century version of the theme and variations. The theme? Dunn's sound-making patch, his self-regulating, self-modulating electronic music set-up which produces a whole family of sounds. The variations? The different equations that ring the changes on the sound-making set-up, and in turn, are rung by the changes from that sound-maker. The clue to the structure? The silences, which are spread throughout the piece. Each of them marks the end of playing with one equation, and the beginning of playing with another. This is a work which is not simply about playing with new mathematical toys—it's a work that exemplifies the structure of those toys, placing human, computer, and sound-making machine into a feedback loop that embodies the essential characteristics of that new science (chaos), and then lets us live within it for an extended period of time. Such generosity on the frontiers of physics, mathematics, and music is rare indeed.

Dunn's work is not only involved with exploring new frontiers of mathematics and synthesis. One of his principal activities is exploring the world of "nature." He's one of the world's experts in the emerging field of bio-acoustics. And in that world, he includes the sounds of people, and their environment. Notice the quotes around "nature." Dunn refuses to accept the distinction between "human" and "natural," instead, realizing that man *is* a part of nature, comes from nature, and may or may not survive depending on the relationship he/she makes with "nature." For many years, Dunn has been involved in researching the sounds of the environment. His recent CD *The Sound of Light in Trees* is a composition made entirely from the sounds he recorded inside pine trees, principally those of the Pinyon Engraver Beetle. This work is being taken very seriously, as it is revealing things about forestry management, insect ecology, and climate change that were not previously suspected. However, another aspect of his work has been setting up interactive systems within nature, whereby humans, machines, and the environment interact with each other. This is a strain of his work that has been going since his earliest compositions, such as 1973's *Nexus 1*, for three trumpeters in the Grand Canyon, and the large ensemble-and-electronics piece *Skydrift* (1977), which took place in Southern California's Anza-Borrego Desert, and is an area of work which he continues up to the present day. In the mid-1980s, as the technology became smaller, and cheaper, he also began a series of works where he tried to set up interactive systems in which the environment could interact with itself. *Autonomous Systems: Red Rocks* is the latest in this series of works, and to my ear, the most elegant realization of the idea yet.

Here's the way the technology works: Environmental sound goes into a microphone. Microphone goes into a small computer system. Small computer system records sound and puts it into memory. Non-linear (chaos) information generators inside the computer choose sounds or bits of sound in memory. The chosen sounds are played back some time after they were recorded, and are either modified electronically or not, depending on choices made by the program. These sounds when played back are also recorded, and become part of the feedback loop. In this system, Dunn does not perform live. He has programmed the system, and then he steps back and observes the interactions that result.

That's the bare technical bones. But what happens is more than the sum of its technological parts. Some of those feedback loops "take," and certain participants in the environment—the flies, the birds—begin to "play" the system, interacting with it. And because of the feedback loops involved, certain resonant frequencies occurring in particular places get reinforced. The sound resulting from the physical shape of the environment itself becomes the musical material that the environment and the electronic system begin to play with, assembling a music, the details of which Dunn could never predict, but the broad behavior of

which he is very much aware of. And although many of David's pieces are site-specific, for our purposes the exact location of this recording is unimportant—suffice it to say that this environment is a bit more moist than Dunn's usual haunts in the New Mexico and California deserts. You can hear that in this recording—the birds are not desert birds, but come from a more northerly boreal setting. What *is* important here is how the environment and the system interact, and the sounding result, which I find almost hallucinatory in its beauty and elegance. And this lovely, gritty soundscape makes me question: If this installation *does* generate a self-regulating intelligent language—if, somehow, the interaction of machine and environment becomes more than just a metaphor, but a "living," "breathing" entity, will we be smart enough to know it, will we be intelligent enough to recognize the intelligence we have given birth to? I mean, we can't even understand dolphins and dogs, and they've been trying to talk to us for years. Can we do any better with the environment as a technologically mediated feedback system? David sure hopes so, and is willing to spend a major portion of his life trying to find out. See what I mean by generosity?

Which brings us to *Gradients*, a work Dunn made with a freeware graphics-to-sound conversion program. In this program, graphic lines become sounding sines, each single pixel-wide line being realized as one sounding pure electronic sine wave. Place enough of these sines together, and space them closely enough, and you get noise—and elegantly shaped noise at that. Different sounds happen in the left and right channels—or rather the same sounds, but in different lengths and directions. The overall structure has elements of self-similarity to it—and this is another area where Dunn's grounding in the classical music tradition shows: Self-similarity, an area of exploration for mathematicians and scientists in the last quarter of the twentieth century, has been around in music for centuries. In the eighteenth century they called it *fugue*; in the early twentieth century, Heinrich Schencker noticed it was an aspect of the structure of traditional tonal music. *Gradients* is a piece that I find almost oceanic, and not just because of the timbre, which can be heard as resembling the sound of the surf. The world of this piece seems to swirl, swoop, and dive. However, here the swoops are more controlled. If the sound world of *Red Rocks* represents nature at her messiest, and the attractor pieces show the slightly less messy world of mathematical abstractions of natural processes, in this piece we have the clean lines and simple shapes of man-made geometry. Remember how I said Dunn viewed man and nature as not separate? In the pieces on this CD we can hear his almost Whitmanian embrace of all aspects of structure, from the most elaborate to the most simple.

What's interesting for me about *Gradients* is the sounds Dunn gets out of this simple software. Many people (including myself) have used these programs for many purposes, but the images Dunn chose to use (the originals are very big—several hundred pixels in size), and the ranges over which he chose to use them, produce a density of noise—and a smooth transition from noise to pure waves, that I didn't think was quite possible with these programs. It's another measure of his skill, and his nearly infallible ear, that the piece is as thrilling as it is. And though I normally like to listen to my music at lower volume levels, this is one piece in which I would recommend that you, however briefly, pump it up. At higher volume levels, the dynamism of the sound is revealed—gloriously.

So how did he get here? Where does someone like David come from? In one sense, his background is normal, and in another, it's quite exceptional. A violin and viola virtuoso as a teenager (with the usual round of youth orchestra solo appearances), growing up in San Diego in the sixties and seventies meant that he encountered people like Harry Partch and Kenneth Gaburo. I also remember him as a student violinist forming a rehearsal string quartet with his friends, where they sight-read pieces like the Ives string quartets. A measure of his connection to the experimental music tradition of the early twentieth century is the fact that in the early 1970s he had two cats—named Ruggles and Satie. He worked with Partch for about five years, and continued to be in his ensemble for a decade after his death. His association with Gaburo was even longer, and lasted until Gaburo's death in the early 1990s. In that time they collaborated on several projects, and the relationship grew from a student-teacher one into one of the greatest mutual collegial respect. And he knows the history of electronic music thoroughly, having been

present for many of the early developments. His 1992 book, “Die Eigenwelt Der Apparate-Welt (Pioneers of Electronic Art),” (the book is in English, despite its German title), written as a catalog for the Austrian Ars Electronica Festival, is one of the standard reference sources for the history of the medium.

For most of Dunn’s life, he has been steadfastly outside academia. He has made his living in a series of more or less interesting day jobs—as one of the first people doing computer music typesetting for a music publishing firm, a manager of an Art-Science research organization, and an environmental sound recordist for various museums and aquaria. He’s also had the occasional teaching gig, but never the luxury of a steady salary, or the respect that an institutional position might bring. More recently, awards have come his way—some of which (the Herb Alpert Award) have been quite lucrative. Perhaps the world is finally catching up with David, and his valuable probing intelligence.

Today, he remains as keenly incisive and aesthetically uncompromising as when I first met him, more than thirthy-five years ago. In preparing for writing these notes, I went back and listened to his entire output available on CD and at his website (www.daviddunn.com/~david). I was struck once again with the uniqueness of his output—despite his continued involvement with a family of ideas, no two pieces sound alike, yet each is the unique expression of the circumstances of its making. Throughout all this, David’s handling of sound, *and* idea, has never been less than adroit. He is not only one of my intellectual favorites, he’s also one of my favorite sound makers, and sound shapers, as well.

—*Warren Burt*

Warren Burt is a composer, performer, writer, and video artist who lives and works in Wollongong, Australia. He has known and worked with David Dunn since the early 1970s.

Composer’s Note

Like many contemporary artworks, all of the compositions on this disc can trace their genesis to the intellectual and mathematical frontiers of “complexity science” and non-linear dynamics. Unlike many of their intellectually fashion-driven kin, they are not merely poetic expressions of contemporary scientific ideas but are structurally generated by the mathematical dynamics of the underlying concepts.

Even though all four of these compositions represent radically different listening experiences generated from similar structural resources, they also share a common historical perspective. Within the Western cultural context, musical practice has often been more or less coupled to the state of mathematical and scientific knowledge. The current state of much musical practice continues this co-evolutionary scenario. We now witness the abandonment of prescriptive formal theoretical models, or so-called “common practice.” In its place we are beginning to see an integration of form and function that is organically determined through the compositional specification of systems and networks that give rise to behaviors reflecting current ideas of emergence, self-organization, biological autonomy, and fractal self-similarity. Rather than musical composition as the specification of fixed details of structure over time, it now becomes the design of a generative system of sufficiently high-dimensional complexity from which rich sonic behaviors can emerge.

This perspective is coincident with one of the more significant reasons for exploring these mathematical ideas through sound: to acquaint a larger public with them. While many scientific fields have embraced “deterministic chaos,” its use often remains metaphorical when describing certain forms of behavior within natural systems. The term “complexity” is used as a broad brush to paint various kinds of surprising and irreversible change (hysteresis) and positive feedback loops that are beginning to be associated with such events as global climate change and loss of biodiversity. Biologist E.O. Wilson has discussed the difficulty that most of us have in comprehending forms of change that are not linear and how this contributes to our inability to see clearly the environmental bottleneck that civilization has

entered. Chaotic and non-linear changes are especially difficult to identify with at a human scale, but whose understanding is essential for setting social and environmental policy in our near future.

Over the past few years I have been collaborating with the physicist James P. Crutchfield on the visual and auditory articulation of scientific and mathematical research in the fields of complex systems and nonlinear dynamics ("chaos"). One of our projects, entitled *The Theater of Pattern Formation,* is a non-technical and aesthetic entry into the world of pattern formation, complexity, and chaos that celebrates recent major innovations in our understanding of the origins of order and disorder in nature and in mathematics. The general project can be characterized as a family of pattern-generating systems that manifest as visualizations and sonifications of a large variety of non-linear dynamical processes and algorithms similar to pattern formation systems occurring in the natural world. These can set the stage for an intuitive grasp of how these complex systems behave and how such regimes among natural systems can be so surprising in their abrupt transitions toward the unexpected.

Lorenz is a real-time sonification of this classic chaotic attractor occurring as both a pitch-based articulation of the phase space and as a slicing through a corresponding spectral domain. The attractor has also been carefully "placed" into the stereo field such that a path along its spatial trajectory occurs with the dominant lobes roughly corresponding to the two loudspeakers. Two such counter-balanced attractors and their trajectories are simultaneously made audible. James P. Crutchfield created the high resolution, real-time Unix code, for the generation of the Lorenz attractor, a computer program called *MODE* (Multiple Ordinary Differential Equations).

Autonomous Systems is a research oriented work-in-progress with many realizations and components focused upon aural articulations of self-organizing systems and principles of biological autonomy. *Autonomous Systems: Red Rocks* is one particular manifestation of this project conceived as an outdoor, site-specific sound installation. The installation uses a small computer system programmed to autonomously process acoustical information from the environment. The total interactive system is driven by self-organizing behaviors that are continuously perturbed by changes in the external environment. The resulting soundscape is a combination of self-organizing autonomous machine-based structures and processed samples from the external world that interact and influence each other.

Nine Strange Attractors uses MODE to generate complex electronic soundscapes from the real-time behaviors of nine Ordinary Differential Equations (Duffing, Lorenz, nScroll, Owl, Pendulum, ProtoLorenz4, Rikitake, Rossler, Van der Pol). Each attractor's unique spatial morphology is driven at various computational rates in real-time, ranging from those associated with its traditional high-resolution visual display to extremely slow rates that reveal greater structural detail through sound. While each equation's sonification is in some sense recursive, their behaviors can overlap and interact in an endless array of combinations and time scales.

Gradients consists of three auditory palindromes for computer-generated sounds, all based on a common structural transformation of three different graphic images. These translations were for a variety of different time durations in both forward and retrograde versions determined by golden mean proportions. As a result of their common structural genesis, all three palindromes also share the attribute of self-similarity with the same generative kernels operating at different levels of temporal scale. This composition is best heard at high amplitude.
—David Dunn

David Dunn was born in 1953 in San Diego, California, and currently lives in Santa Fe, New Mexico. He has worked in a wide variety of audio media: traditional and experimental music performance, installations for public exhibitions, video and film soundtracks, radio broadcasts, and bio-acoustic research. Much of his recent activity involves the design of tools and systems for environmental sound monitoring in both aesthetic and scientific contexts.

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For more information, please visit the composer's website at http://www.daviddunn.com/~david

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1. *Lorenz* (2005) 22:43
2. *Autonomous Systems: Red Rocks* (2003) 9:56
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4. *Gradients* (1999) 14:16

Total Time: 67:24

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