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Buchla's Box

Some of my best friends are keyboard players.
DON BUCHLA

AT ABOUT THE SAME time that Herb Deutsch was asking Bob Moog if he could make *woo-woo-ah-woo-woo* sounds, two experimental composers, Ramon Sender and Morton Subotnick, were collaborating with electronics specialist Don Buchla to develop new devices for making electronic music. Buchla's invention, the Buchla Box, conceived of quite independently from Moog's, could not have been created in a more different place. While the Moog was born in a tiny upstate New York town, the Buchla Box came into existence in radical 1960s San Francisco. The different circumstances surrounding the birth of the two instruments decisively shaped their form and use.

Don Buchla was born in Southgate, California, in 1937, three years after Bob Moog was born. His father was a test pilot in the Air Force and his mother was a teacher. He was raised both on the West Coast (California) and the East Coast (New Jersey). His background appears to have been very similar to Moog's. He is from the same generation, and as a kid he too studied piano.

Buchla has always been involved with music. During his career he has made new instruments, composed electronic music, learned to play flamenco guitar, jammed with the Grateful Dead, and given numerous performances using his own synthesizers and other instruments. He describes himself today as neither an engineer nor a musician but "a traditional builder of musical instruments."

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On the Edge

Buchla's childhood talent was electronics. Like Moog, he was a tinkerer who got his start building crystal sets and messing around with ham radio. "I had a natural facility for electronics. I never studied it, I just picked it up as a child . . . I sort of regard it as a tool, much as a car mechanic regards a monkey wrench as a tool. It's not something that you study, it's just something that you use. I used it."

In 1955 he enrolled at the University of California, Berkeley, and graduated with a major in physics in 1959. He went on to do graduate work in the field but never finished his PhD. His special talent for electronics was increasingly recognized. The University of California's Lawrence Berkeley National Laboratory had one of the first particle accelerators and was a leading center for the newly emerging discipline of high-energy physics. Buchla worked there building klystrons—devices for producing high-frequency electric fields that accelerate the particles in an accelerator. This turned out to be a good training ground for a career in analog synthesis: "It's partly because I went in there without an engineering degree, and didn't know how anything was supposed to be done." Like Bob Moog, Don Buchla stresses the limitations of academic knowledge. He regards himself as an experimenter; he started off experimenting and he's been experimenting ever since: "I always figured that if I made something that was too popular that I was doing something wrong and that I had better move on . . . I regard myself as more in the avant-garde, kind of experimental phase. And I've always enjoyed *being on the edge*, working on new things, and encountering people that were working with new things."

The 1960s was an opportune time to do new things. The space age was

taking off, and electronic sounds had always been part of the mystique of space—the bleeps of the first Sputnik emerging from the background hiss of early radio receivers is etched into the Cold War consciousness. But space meant something else to synthesizer pioneers: it meant a source of employment. NASA needed engineers. Before founding the synthesizer company ARP, Alan Pearlman made equipment for NASA, and Don Buchla's talent for electronics too soon found a new home in space.

Berkeley administered a number of NASA projects. Buchla took part in some of the first investigations of the Van Allen radiation belt in the magnetosphere above the earth's atmosphere. He even directed a project to explore the feasibility of sending chimpanzees to Venus (conclusion: not feasible). He has worked on and off for NASA throughout his career. NASA contracts are one of the few forms of financial security available to the maverick synthesizer designer: "They don't pay much, but they pay more than music . . . and it has been fascinating work."

At NASA Buchla met and worked with the first generation of astronauts. This gave him an opportunity to explore an interest that stretched back to his childhood and that would obsess him the rest of his life: human–machine communication, "just a general interest in how man communicates with machines. I started it as an early child and it continues. And music brings out many of these problems."

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The Berkeley Drop Out

The Berkeley Physics Department at this time—during the height of the Cold War—was becoming immersed in politics. Physicists were being asked to make political declarations of loyalty and testify before the House Un-American Activities Committee. The protests against McCarthyism were centered in San Francisco and Berkeley. In September 1964, when UC Chancellor Clark Kerr enforced a gag order against politicking on the

Berkeley campus, the Free Speech Movement was born. Don and his fellow scientists joined the protests. As the sixties unfolded, Don's increasing immersion in the counterculture made a formal career in physics less and less likely. As Don told us, he "dropped out." By this point he had almost certainly "tuned in" and "turned on."

One person who knew Buchla well is Suzanne Ciani. Today, Suzanne is a highly acclaimed Grammy-nominated musician whose New Age–style albums have brought her commercial success.[1] Back in the early seventies, she was a struggling electronic music composer who desperately wanted a Buchla synthesizer and who started to work for Buchla to save up enough money to buy one. Suzanne described Buchla as a "true original thinker, a Renaissance Man," a man with a "vision": "He had glasses and kind of longish hair . . . We called him Buch the spook . . . socially he was pretty shy, and when we were working, in the factory there, Buchla would walk around . . . making these funny noises. He sounded just like a machine . . . He was a very private person, very independent. Very driven, focused and really impassioned by what he was doing—endless energy."

Buchla refused to make concessions to the world around him. He was determined to follow his radical path for the synthesizer, wherever it might lead him.

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Experiments with Sound

Buchla's overriding talent in all the different areas where he worked was electronics. And with the new form of miniaturization offered by transistors, electronics became a more and more useful tool. Before he developed his synthesizer, several of his early projects involved sound, if not music. With the support of the Indian medical profession, he designed a new form of transistorized hearing aid; at the time, hearing aids in the United States still used vacuum tubes. To aid blind people, he built a device that

changed pitch according to its proximity to objects. He also built miniature amplifiers, "but then the FBI got interested and I got uninterested." As Theremin in the Soviet Union found, governments had their own uses for the revolution in electronics.

It was during his time at Berkeley that Buchla became fascinated by electronic music. No doubt it was an opportunity for him to experiment some more. He played around with the standard techniques like *musique concrète*, splicing together a composition made out of the sounds of insects. He owned a one-track tape recorder, but he wanted something better. In 1962 he spotted what he was after at a concert at the San Francisco Tape Music Center. It was a three-track Ampex tape recorder that had been specially designed for film work. He borrowed the machine and started to hang out at the Tape Center.

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The San Francisco Tape Music Center

The Tape Center had just been formed by electronic music composers Ramon Sender and Morton Subotnick. Sender had come to the United States from Spain as a child refuge from the Spanish Civil War. As a composition student at the San Francisco Conservatory, he had put on his own electronic music concerts.[2] The first one, "Sonics I," in the fall of 1961, had premiered work by the up-and-coming local composers Pauline Oliveros, Terry Riley, and Phil Winsor. Sender encouraged his performers to improvise and called that first concert "bring your own speaker night." It was after this concert that Subotnick, a composer teaching at Mills College, got involved. They were soon putting on electronic music concerts together. Their 1962 series ended with what Sender describes as an early "happening": "We projected a film on the patio concrete and had the dancers dancing in it. And we had one person inside a piano . . . the audience was encouraged to walk around the building . . . I found an old cast iron aluminum laundry machine which we filled full of rocks and turned on, and had a long extension cord that allowed us to wheel it down the corridors. It was quite thrilling . . . and sort of strange." Sender had introduced more visual elements and audience participation because he discovered that audiences did not like just listening to tapes. This was a problem endemic to electronic music before the synthesizer: without a performer, a concert was terminally boring to watch.

Subotnick had some equipment in a garage, and Sender came up with the idea of asking other composer friends, such as Oliveros, to pool their equipment in one studio location. Thus was the San Francisco Tape Center born, first located in a house on Russian Hill and then on Divisadero Street.

The center soon acquired the reputation for staging some of the most avant-garde music and multimedia happenings in the Bay area. Composers John Cage and David Tudor gave a much-celebrated series of concerts. Karlheinz Stockhausen lectured. Terry Riley and Steve Reich were just starting their careers. Terry Riley's "In C," commissioned by the Tape Center, was premiered there in 1964, and Steve Reich's "It's Gonna Rain," also commissioned by the Tape Center, was played in February 1965.[3] Nearly every concert involved some form of improvisation.

The Tape Center was also a working studio. It made electronic music in the traditional way, by cutting and splicing tape. The musicians used just about anything they could lay their hands on for sounds. They raided junkyards, borrowed from local industries and universities, and accumulated piles of war surplus. As Bill Maginnis, the center's technician, told us: "There were bits and pieces of World War II bombers that we had. Also . . . someone had raided the rad lab [Radiation Laboratory] at Berkeley, and we had bits and pieces of stuff that said 'University of California Department of Physics and Cosmic Rays' on it."

Subotnick and Sender were, however, searching for better ways to do things. They wanted to "move away from cutting and splicing to get something that was more like an analog computer."[4] What they were thinking of

was a "black box" for composing. Instead of having to go to a big studio, composers would have access to this inexpensive piece of equipment in their own homes. Sender and Subotnick on the West Coast were driven by precisely the same needs as Deutsch on the East Coast. They too wanted to use the new electronics to help electronic music making become more portable and affordable.

Bill Maginnis still remembers the moment he was hired as the center's technician. He was a working jazz drummer and had gone there to get a circuit diagram for a ring modulator. Ring modulators are devices first used in radio for multiplying two waveforms together. The resulting output (the sum and the difference between the two frequencies) is musically interesting because the output frequencies have no musical relationship to the input frequencies. They produce very strange bell-like sounds because of the altered harmonic structure. Maginnis: "So I walked into the Tape Center and Ramon Sender was standing there . . . He said, 'If you had a schematic, could you build it?' And I said, 'Sure, yeah.' He reaches in his pocket . . . starts fumbling with his keys, he says, 'Here's the key to the front door, here's the key to the lab.' I said, 'What, what, what?' He said, 'Oh, you're our new technician.'"

Maginnis first became aware of Buchla and his talent for electronics when Buchla offered to help him build the ring modulator: "You don't have to go through all this trouble, it's easy, just give me four diodes and I'll build you a ring modulator." Maginnis still has that hand-soldered ring modulator, which was the prototype for the one Buchla built into his first synthesizer.

Buchla saw what the Tape Center was doing and realized that the field was ripe for the application of electronics to music. He started to discuss his ideas with Subotnick. Maginnis too had a role to play; he found he was translating between the engineers and the musicians.

The idea of an "intentional" electronic music device—one that was designed from the start to make electronic music rather than using equipment designed for other purposes—slowly developed. Subotnick suggested that using a light source to control sound might be promising.[5] Despite being skeptical of this approach, Buchla built the device, and less than one week later showed up with it on a plywood board. Subotnick: "This was a disk that rotated and had little holes in it, with a light that shone through it onto a photocell. By changing the position of the holes, you could change the harmonic structure of the signal at the output of the photocell."[6]

Buchla's skepticism proved to be correct. After building this device, he announced to Sender and Subotnick: "This is the wrong way to do it."[7] Maginnis too was experimenting with light and photoresistors, which he used in conjunction with relays to make a rudimentary form of envelope generator. Later he turned this into an electromechanical sequencer by introducing step relays and a dial. It only had ten even steps before needing to be reset, so it was not useful for making any sort of rhythm.

The funding of the Tape Center was always precarious, but finally Sender and Subotnick persuaded the Rockefeller Foundation to give the center a small grant, $30,000, to run their program for the 1964–65 season. Five hundred dollars was allocated to Buchla to work on building the intentional electronic music device.

Buchla's familiarity with silicon transistors and his knowledge of analog computers (from working in physics) led him to voltage control: "I had this idea you could take voltages and multiply and mix them and things like that. So it wasn't too far a cry for me to attach a voltage to the pitch of an oscillator or to the amplitude of a VCA . . . But as soon as I added voltage control to the elements of the synthesizer it became a different ball game because you could parametize everything. You weren't limited by how fast you could turn a knob to get between two states of a parameter."

Buchla, like Moog, realized that voltage control had the potential to revolutionize the way sounds were controlled. But Buchla was after something different; he wanted to eliminate the time-consuming practice of splicing tape altogether. By thinking of ways to do this electronically, Buchla

was led to the electronic sequencer—a device that later was used to make much influential pop, rock, and dance music. A sequencer produces predetermined control voltages in a cycle or sequence and can endlessly recycle these control voltages at a frequency predetermined by the user. In Buchla's first sequencers there were three control voltages per step, and his first "sequential voltage sources" had eight voltage steps (later sixteen). It was a rudimentary way to program a voltage-controlled oscillator to play a series of different pitches one after the other—in effect, a tune. As the notes repeat, the sound can be shaped and subtle changes in rhythm and timbre introduced. Buchla: "You wouldn't have to splice 16 pieces of tape together if you wanted a sequence of 16 notes. You could simply take my sequencer and set the time and the pitch for each interval. So that required, of course, a voltage-controlled oscillator and sequencer, and from then it led to a bunch of other ideas."

The idea of using electromechanical ways to sequence a series of sounds was very much in the air. Peter Zinovieff in London was also working on rudimentary sequencing devices, as was the pioneering jazz musician and inventor Raymond Scott.[8] But there was no doubt that Buchla, with his electronic way of doing it, had achieved a breakthrough. The sequencer was the one module that Moog eventually "copped" from Buchla.[9] Sender and Maginnis were impressed by what Buchla was developing. Maginnis: "Ramon had seen what Don was doing and came back and said, 'Hey, he's got a thing sort of like your dial that is really, it's incredible.' I said, 'Really?' And what it was was a sequencer."

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"An Exciting Day"

Bill Maginnis still remembers the day that Don brought his prototype Buchla Box into the Tape Center for the first time in late 1965: "And he says, 'Well, here it is.' . . . Well, everybody was gathered around up until about 10 o'clock in the evening playing with it. They all left and I stayed there all night long, playing with this thing." Before leaving in the early morning Maginnis programmed the sequencer to play the first eight notes of "Yankee Doodle." "I knew Pauline [Oliveros] was coming in in the morning and she wanted to work on something . . . So I get this call at 10 o'clock in the morning from Pauline saying, 'How do I turn this damn thing off?'" Pauline had a very different way of making electronic music and was rather indifferent to Buchla's device.[10] We asked Buchla about that day: "It was an exciting day . . . and I hooked up the sequencer to the voltage controlled oscillator and turned the knobs. And Terry Riley said, 'I think I'll do some music on that.'"[11]

Maginnis was amused to point out to us that the original Buchla Box, now at Mills College, still has modules that are tack-soldered with components attached to posts. That first prototype also had gaps for modules that Buchla had yet to design. Like Moog, Buchla had no idea how important synthesizers would become. At the Tape Center, it wasn't as if the whole future of electronic music-making was about to change. Maginnis: "It was incomplete . . . It was just another device going in. But this one said San Francisco Tape Music Center on it instead of Hewlett Packard."

Buchla was reluctant to call his device a synthesizer. For him the word synthesizer had (and still has) connotations of imitation, as in the word "synthetic," meaning rayon and other man-made fibers. He did not regard his new instrument as a vehicle to imitate or emulate the sounds of other instruments. He eventually called his instrument the Buchla Music Box Series 100. It was often referred to as the Buchla Box or simply the Buchla.

Buchla came up with his invention without any knowledge of what Moog was doing on the East Coast at about the same time. Buchla got started a few months ahead of Moog, but Moog's first prototype was finished in the summer of 1964; Buchla's appeared in the fall of 1965. The two inventions were very similar: both were modular, were connected by patch wires in flexible combinations, and used voltage control for the oscillators and amplifiers.

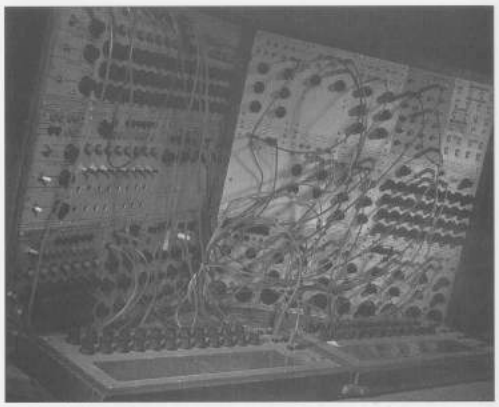

Figure 7. Buchla 100 Music Box

There were, however, some differences. They initially designed different modules: Buchla had a ring modulator and sequencer; Moog later added a sequencer and manufactured a rack-mountable ring modulator designed by Harald Bode (designed before either Moog or Buchla made their prototypes). On the other hand, Moog had a filter, which Buchla later added. There was also the one difference that would become important for the future of the synthesizer: Buchla's lack of a standard keyboard. He provided instead a series of touch-sensitive pads that produced three different voltages the harder you pressed the pads. On the first Buchla Box he built for the Tape Center, these pads were used to control a set of *musique concrète* tape loops that Subotnick and Sender had made.

Moog and Buchla may have started at the same point, but they ended up at very different places. They were both socially awkward young men who found solace in their hobby of electronics. Both had some familiarity and interest in music and did their graduate work in physics departments at leading American research universities. Both were interested in exploring new things, and neither of them had any experience of the commercial world of instrument manufacture. Their hobbyist background and independence meant that they could tinker and experiment freely without the constraints that a corporate setting might have imposed. The hobbyist tradition provided them with a community and a network within which they could comfortably operate and design new devices. Both had enough training in, and understanding of, electronics to recognize the importance of the development of transistors and advances in voltage control. Crucially, both of them, at key moments, encountered the world of avant-garde electronic music—Moog in New York and Buchla in San Francisco. But the degree to which they were immersed in the world of the avant-garde would produce important differences in their synthesizers.

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Strange Arrays

Some people have said that Buchla is anti-keyboard, but they misunderstand him. He considers the keyboard a perfectly good way of doing what it does well, which is making polyphonic music based on a twelve-tone chromatic scale. It just never occurred to him that such a device was an appropriate way to control electronic sound: "It was a potentially new source and therefore instruments based on it would probably be new and different." Buchla was committed to this vision of doing something completely new.

He felt that going the keyboard route was reverting to an older technology: "I saw no reason to borrow from a keyboard, which is a device invented to throw hammers at strings, later on operating switches for electronic organs and so on."

Buchla wanted something more imaginative as a controller, something that would connect the performer to this new source of sound. No doubt his life-long interest in human–machine communication was part of his motivation to improve on the keyboard. His arrays of touch-sensitive metal pads housed in wooden boxes were designed to be more user-friendly. Buchla had a special name for these devices: kinesthetic input ports. Although these pads could be tuned to play the twelve-note chromatic scale, Buchla's whole design philosophy was to get away from the constraints of the standard keyboard.

His attitude was shaped by the experimental composers he met at the Tape Center. John Cage and his collaborator, David Tudor, were exactly the sort of artists with whom Buchla identified. Cage used Buchla's touch pads to control one of his favorite pieces of equipment, the voltage-controlled FM radio receiver (which he used as a source of electronic sound for musical performance). Each pad was used to control a different station. Buchla's first-ever sale was to David Tudor, for whom he designed a set of five circular pads that could move sound around a space, from speaker to speaker.

In Buchla's vision of a keyboardless synthesizer, the operator would be stimulated to explore the new sounds of which the new instrument was capable: "A keyboard is dictatorial. When you've got a black and white keyboard there it's hard to play anything but keyboard music. And when's there not a black and white keyboard you get into the knobs and the wires and the interconnections and the timbres, and you get involved in many other aspects of the music, and it's a far more experimental way. It's appealing to fewer people but it's more exciting."

Mass appeal was not Buchla's goal. He saw no particular need to standardize his modules in terms of the conventional musical scale. In other words, he did not share Moog's commitment to the one-volt-per-octave standard. The Buchla, built without a conventional keyboard, could not be described according to this standard at all. Buchla had no need to use exponential converters on his oscillators. "Our original oscillators were actually linear rather than exponential. In fact the original ones were not even linear; they were something in between. So I can't give a volts-per-octave figure."[12]

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Buchla Goes Bananas

Another subtle difference between the technologies of Buchla and Moog lay in the sorts of patch cords they used. Patch cords are the wires that allow the operator to flexibly connect up the different modules on a synthesizer. Buchla used two different sets of patch cords with different sorts of wires and plugs for "signal" and "control" voltages.[13] Signal voltages are voltages in the audio range of frequencies, while control voltages are typically of lower frequency. Buchla routed the control voltages through unscreened wires with plugs at each end, known as banana plugs, that could be stacked one on top of the other. The signal voltages were routed through screened wires and phono plugs. "It was to prevent the user from interchanging the two. Because a module that optimized for one function was definitely not optimal for the other function."

Moog, on the other hand, used standard jack plugs and screened wires for all his patch cords, making no distinction between the two sorts of voltage. Buchla felt that his separation of signal from control voltages made more sense electronically. For example, he could invert control voltages (turn a positive voltage to a negative one), but it made no sense to invert audio voltages. Modules designed for the audio range such as voltage-controlled amplifiers (VCAs) could be differentiated from ring modulators which worked in the control realm. Mixing the two together was, for Buchla, like building a "car which could also float." In short, a disaster.

Another advantage Buchla claimed for keeping control voltages separate from signal voltages was that it helps a composer to understand more easily the structure of a complex patch. "You can look at the system and see where it's at. That invites more complex systems. Mort Subotnick was I think 'King of the Wires' on that . . . you could put in a lot more complex structures and still not confuse them with the sounds." In other words, by stacking the banana plugs one on top of another, a complex pattern of control voltages could be established without inadvertently confusing this structure with the audio sounds themselves.

This difference was much less salient for Moog: "In order to separate them you'd have to think you would never want to use an audio signal as a control . . . and I just never saw that—that's not something that we'd want to decide up front. I'm not sure there is an advantage to doing it his way, other than a conceptual [one], there's less chance to mix up control voltages with the audio, so maybe his was easier to use, to think about for musicians, but mine was more versatile."

Moog's rather different design philosophy can be seen at work here. Why constrain the users? If the users wanted to mix up control voltages with audio, why not let them do so? The Moog way of doing things was to let users decide these sorts of questions for themselves. On the other hand, from Buchla's perspective he was providing composers of experimental music a way to make very complex patches easier to follow and thereby encouraging them to experiment.

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The Source of Uncertainty

Buchla created his own unique series of names for some of his modules. All synthesizers, including Moog's, have devices for generating noise that are particularly useful for producing percussive effects and other sounds like rain, waves, thunder, and wind. White noise, as it is known, is analogous to white light in that it contains all sound frequencies. Because human hearing gives prominence to higher frequencies, we hear these slightly more in white noise—to us, it sounds like steam escaping from a radiator. Pink noise is white noise that has been filtered to boost the lower frequencies (formally, it has equal energy per octave). Rather than call his noise sources white noise or pink noise, which became the terms favored by most manufacturers, Buchla on his System 200 (introduced in 1969) named them "the source of uncertainty."[14] The source of uncertainty served primarily as a random source of control voltages (which could involve, for instance, selectable probability distributions and voltage-controlled rates of change) and thus was a way of introducing randomness into compositions.

Another module on the System 200 was called the "multiple arbitrary function generator." Buchla maintains that these names, like "kinesthetic input port," were chosen because they described as accurately as possible what the device or module did: "It wasn't that I was trying to be different; I was trying to be accurate . . . 'Source of uncertainty' meant precisely what it says. 'Random function generator' means randomness. Randomness suggests just that, a random walk or something. 'Source of uncertainty' means uncertainty is a thing that you deal with. It's not something random. If you want some uncertainty it's a positive attitude." Buchla was asserting the rather different esthetic behind his vision.

The Buchla Box was designed for musicians who wanted to produce a complex piece of music in real time. The sequencers and the source of uncertainty enabled the operator to set off complex chains of events that could feed back on each other. It favored a certain sort of composer and style of composition. Moog: "There are also people like Morton Subotnick and Suzanne Ciani who are concerned, as Cage was, with production of music as process, where to realize your music, you would organize a very complex system. The Buchla modular system was designed with this sort of composer in mind more than ours was. It has a lot of capability for triggering sources in sequence, for turning on and off different sources, and for creating a very complex organization of a modular system. You can literally set up a machine that will produce an interesting sounding piece of music by itself."[15]

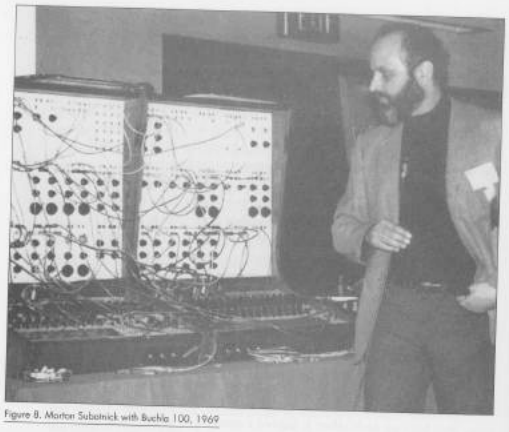

Figure 8. Morton Subotnick with Buchla 100, 1969

The acknowledged "king of the wires," Morton Subotnick, found the Buchla to be a totally new way of composing electronic music. This is how he made his acclaimed album *Silver Apples of the Moon* (1967; title from a poem by W. B. Yeats), created on the Buchla 100.[16] Subotnick: "I purposefully did not know what results I was after. I believed that with this new instrument, we were in a new period for composition, that the composer had the potential for being a studio artist, being composer, performer, and audience all at once, conceiving the idea, creating and performing the idea, and then stepping back and being critical of the results."[17]

Suzanne Ciani has used Moogs and Buchlas. Although players obtain immediate aural feedback from both instruments, and there is tactile satisfaction from interacting with keyboards, touch plates, and potentiometers, Buchla was interested in involving as many senses as possible and added multiple arrays of indicator lights on his System 200: "There were lights on everything, because that was your feedback . . . even [on] your source of uncertainty. If you wanted to know the rate or the intensity of that voltage, the light told you that, so you could tell, 'Oh, gee, I'm having a very rapid rate of uncertainty,' or a slow rate."

Ciani felt that the Buchla offered more subtle controls such as the three-dimension sequencing ability of the multiple arbitrary function generator and the ability to mix oscillator waveforms (a feature the VCS3 would also have).

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Art for Art's Sake

Buchla was developing a unique way of doing things. His synthesizer was geared toward a certain sort of user. And there were like-minded composers who saw the merits of his approach. No less a figure than Vladimir Ussachevsky visited the Tape Center and ordered three of Buchla's systems, one for each of his identically furbished studios at Columbia-Princeton. Buchla's synthesizers appealed to Ussachevsky's way of working as a composer: "The Buchla synthesizer was logically arranged to be more accessible to composers' thinking . . . than Moog's synthesizer. This is not to say that Moog's modules were not awfully well made, very enduring, and in certain cases certain of his modules *at that time* were superior to Buchla's in quality . . . I felt that somehow it did not have enough flexibility."

Ussachevsky's order led Buchla to form his own company, Buchla and Associates. His first shop on Ashby Street in Berkeley was a storefront, little

bigger than a garage: "I wouldn't call it a factory . . . we would lay our equipment out on the sidewalk to have enough space to work with things and on rainy days we would just [acts out picking up the gear]." Later, he had the studio shop in Oakland where Suzanne Ciani first worked for him. Most of his early sales, before word spread, were for customized modules ordered by composers who visited the Tape Center.

Buchla has always been uneasy with commercial production. He regards himself as an artist who, as Ciani put it, "lived off his art." Buchla: "I don't regard it as important to be a commercial success . . . It's a fine line to tread, and you want to stay in the arts at the creative end of it and not mass produce anything, and yet you still have to make a living if you choose to do it."

His artistic vision has had consequences, however, for the commercial success of his synthesizer. Because he did not set himself up as a mass manufacturer of synthesizers, he was never able to sell many systems. Also, being a small designer based in one location meant synthesizers had to be sent back to his studio for repair and service, and all of this trucking around occasionally damaged their delicate electronic innards.

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Buchla and CBS

In 1969 Buchla did venture into a more commercial form of production when he licensed his designs to CBS. Electronic music was taking off, and CBS hired staff who developed slick demonstrations of the Buchla. For a while the Moog company was worried by the impact that Buchla/CBS might have, but CBS's arrangement with Buchla fell through.[18] He does not like to talk much about this episode, which was not a happy experience for him.[19] "They thought they wanted to branch into musical instruments. There were quite a few CBS systems sold. They really got into production. But then they dropped the ball. It was too small a market and too narrow a focus. Their Fender guitar business was booming and they wanted the larger market that that represented, and it was clear to them that electronic instruments were destined to be on the fringe."

When Ciani first met Buchla, he was still bitter about the CBS experience: "He was very alternative, so he knew that he was making something that was, in a sense, anti-establishment. It was new. The establishment, as we called it at that time, was dangerous because they took things over and they homogenized them." It must have been difficult, indeed, for Buchla as a countercultural artist to be dealing with part of the "establishment" like CBS.

With the CBS episode behind him, Buchla returned to his low-key operation, making systems for his own use and for a small number of like-minded composers and academic studios. It's a way of operating that he has followed to this day. "It's a niche market . . . The stuff got popular because it sold to a lot of education institutions and a lot of them had high exposure. I mean until this day . . . if I go into a store and buy something and they see my name on my credit card and say, 'Boy, I learned on your system, it's in such and such a school.' Twenty-five years ago it was very common." One university to buy a Buchla was Harvard. The famous minimalist composer John Adams learned synthesizer on a system that the Music Department purchased in 1969. Although less well-known than the Moog, Buchla's synthesizers have been a source of inspiration to many artists and composers.

Buchla never was part of the electronic instrument manufacturing fraternity. He did attend one AES meeting, in 1971, where he met Bob Moog for the first time. But while there he "offended all kinds of people." By refusing to rent a booth and instead playing a concert, and thus gaining lots of free publicity, he broke most of the rules for such conventions. And to this day Buchla continues to break all the rules. Over the years he has made an extraordinary variety of analog and digital synthesizers and different sorts of controllers.[20] His synthesizers are still known only within a small circle of people, but he has kept ownership of his own company and after thirty years is still making synthesizers and practicing his art.

Moog, in 1975, perhaps chastened by his own experiences in the commercial world, came to appreciate Buchla's anticommercial stance: "I have to admire what Don Buchla has done. He hasn't allowed himself to limit the complexity of his instruments to meet the demands of the so-called marketplace. It has been the conventional wisdom for some time that a complicated piece of electronic music equipment can't be sold off the music store floor. Buchla has chosen not to worry about this."[2]

Buchla has garnered the reputation of being the odd ball in the synthesizer field. What counts as odd, of course, depends on what is going to count as normal. Back in 1965 it was not at all clear that the synthesizer would appeal to a mass market, and also it was not clear that it would become primarily a keyboard instrument. To understand how all this occurred, we return to Trumansburg, to see what Bob Moog was up to.

3

Shaping the Synthesizer

The Moog filter design is as unique to the sounds of the synthesizer as the Steinway steel frame is to the piano.
HERB DEUTSCH

BOB MOOG WAS excited. He may have been only a graduate student, but he had made a start in the electronic music instrument business. He had built his first synthesizer modules, he had three precious orders, and he had his beloved shop. And the shop was soon going to expand.

The Modular Moog synthesizer, which was advertised for the first time as a "synthesizer" in 1966, emerged over a period of time from a thousand different design decisions and a thousand conversations. It was an *innovation* rather than an invention.

The history of technology tells us that inventions are two a penny. There are many, many people who invent new things: machines, processes, tools, gizmos, gadgets, widgets, and the like. Such people are often portrayed as unsung heroes, ahead of their field, unrecognized in their own time. But singing in the bath is not the same as singing on stage. There are very few people who successfully turn their inventions into a real product that can be manufactured, marketed, and sold. The field of electronic music instruments is littered with inventions, but there have been very few true innovations.

One of the most spectacular inventions is Thaddeus Cahill's Telhar-