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Moog Sonic 6 [Six] Analogue Synthesizer (Retrozone) March, 2002

By Gordon Reid

Comments by Jim Scott (September 2023) in RED below. Comments by Tom Rhea in BLUE.

The pioneering Sonic 6 [Six] has a complex and intriguing background, featuring not only the synth industry's most famous name, Bob Moog, but also that of an unsung hero called Gene Zumcheck — a shadowy figure now, but one whose contribution to synthesis deserves acknowledgement.

Gene spelled it Zumchak, not Zumcheck.

Call me a heretic if you like, but I sometimes wonder why we make such a lot of fuss over Bob Moog and the synthesizers that bear his name. Sure, they were good and, in one or two cases, excellent, but there were an equal number of flops and— to be polite — almost as many blunders. [Such as?]

We “make a lot fuss” because it was Bob Moog who developed the archetype for an entire industry!

In part, the reverence must be due to the fact that Moog was a pioneer, a trailblazer who, back in the 1960s, offered us magical new sounds and new musical experiences. Indeed, his early instruments helped to create entire genres of modern music where none had previously existed. But is this sufficient reason to worship Moog, and to afford him the title of 'Godfather of Modern Synthesis,' as many now do?

Bob Moog never thought of himself in such outlandish terms as Reid says above. In fact, Bob often quipped that what he had done was “a nerdish form of golf!” To channel Eric Clapton’s (and others’) comment “ . . . other people’s opinions of [Bob Moog] are none of [his] business!”

To answer this, I'm going to offer you an alternative view of the development of Moog's synthesizers. To be honest, many of the events described in this article took place when I was barely out of short trousers, and I can't be sure that they are the only interpretation of the story that unfolded between 1969 and 1972. Nonetheless, I'm fairly sure that I've got it right, so I'm going to use this month's retro to explode some myths...

“To be honest . . . “ we don’t need an “interpretation of the story,” So, even though he “was barely

out of short trousers," Mr. Reid is "fairly sure that I've got it right." No, he simply did not!

The Birth of The Sonic V

During the late '60s, R.A. Moog Inc. was based in Trumansburg NY, and employed an engineer and designer named Gene Zumcheck. It was Zumcheck, together with fellow engineer Bill Hemsath, who badgered Bob Moog to design an integrated synthesizer that players could use without resorting to a spaghetti junction of patch leads. Unfortunately, Zumcheck and Moog were reportedly not what you could call chums, and Moog declined to develop these ideas, so Zumcheck left the company.

Following his departure from R.A. Moog Inc., Zumcheck was approached by a chap named Bill Waytena, who claims independently to have had the idea that an integrated synth would be of interest to schools and colleges. Precisely how Waytena and Zumcheck (who, legend has it, were both Ukranians) met is shrouded in history. However, there's no doubt that Waytena and his company, muSonics, made it possible for Zumcheck to design and build the Sonic V — the integrated synthesizer he'd wanted to build while working for Moog.

Zumchak was a relative of fellow Ukrainian Bill Waytena. As a kid he bought eggs from Waytena's mother down the road in Elmira, NY. Gene was instrumental in prevailing on Bill to found muSonics under the umbrella of Venture Technologies. The parent company was in the business of buying struggling tech startups, getting design, managerial, capitalization and production problems straightened out to some degree, [managing] the books big time, and selling for a tidy profit.

We called it "Vulture Technology." muSonics, the only Venture Technology startup, developed the Sonic V for the educational market per Gene's overall design and specifications. Gene was a poor analog circuit designer (part of the reason he got fired by R.A. Moog Inc. Trumansburg, NY). So, a moonlighting contractor, Fred Reinagel, was brought in to correct and advise re the detailed circuit design. Essentially, in addition to specifying the instrument, Gene served as Fred's technician and Fred was primarily responsible for the high-quality detailed circuits that emerged.

This comprised a pair of oscillators, a diode ladder low-pass filter (which side-stepped Moog's patent on his transistor ladder filter), two LFOs, and a single contour generator — and it could be programmed and used without the aforementioned spaghetti junction of patch leads.

With its sturdy wooden case, well-designed control panel and four-octave keyboard, the Sonic V should have been a huge success. Unfortunately, it wasn't. But Waytena was no mug, and he knew why. He realised that, without a recognised name to stick on the nameplate, he was going to sell very few synths (and you thought that designer labels were a recent phenomenon?). At this point, fate stepped in. [Wrong again Mr. Reid. Even *after* the Sonic Six had that "recognised name" (Moog) on it, the instrument never became popular! This betrays your lack of understanding of the marketplace.]

Much [nonsense] here. Zumchak principally, ca. Sept/Oct 1969, campaigned to Bob for the company to develop an "integrated" live performance synthesizer. Gene was on this crusade when I came on-board 15 Sept 1969. The management and engineering staff agreed with him. However, he did not prevail with Bob, who foresaw no significant market and furthermore had no interest in mass production of identical instruments, cookie-cutter fashion. Gene was fired as the first casualty of an engineering staff reduction.

Hemsath, on his own initiative, using mostly cast-off components, on his own time and without any official sanction, built the Mini [Minimoog] Model A and had it completed before Thanksgiving 1969. [Gene talked–but Hemsath walked. Hemsath acted!] We do not know exactly when Gene got the axe.

Maybe he was still on the staff when A Model was completed - possibly even when the B Models were in the works in the spring of 1970. Zumchak developed the Synth 10 for Vako [David Van Koevering] while still at the Moog works in this late 1969 period, so maybe that will put a date on the timeline.

Back in Trumansburg, not everything in the synthesizer garden was rosy. Bob Moog's engineering credentials may have been of the highest order, but perhaps his business acumen was not. Despite the explosion of interest in electronic music fueled by innumerable, ghastly “Moog” records in 1969, R.A. Moog Inc. was insolvent. By the end of 1970, the company had an empty order book, and there was significant competition in the shape of ARP, whose synthesizers offered advantages over the equivalent Moog instruments. Something had to change and, when Waytena discovered that Moog's company, and therefore the Moog name itself, was up for grabs, the pieces of the jigsaw fell into place.

Waytena was an entrepreneur, a specialist at revitalising bankrupt or insolvent companies and then selling them for a profit. So, he bought R.A. Moog Inc. for the cost of its debts ($250,000) and moved the company to a converted gelatin factory in Buffalo, a city near the Canadian border in upstate New York. Moog hated the place, but that didn't stop Waytena from merging his two synthesizer companies there to create Moog/muSonics, an entity that soon metamorphosed into Moog Music.

By the end of 1970 the MiniMoog Model D had been developed as an intermediate step toward the eventual production Model, the Mini E. It was intended to demonstrate and stimulate the market, plus attract an investor and also to produce enough cash flow to allow survival for a while longer. We were on the verge of bankruptcy with Bob personally on the hook for the quarter million dollars in debt load.

Through the summer of 1971 cash flow from Mini sales, primarily to Vako, kept the doors open while negotiations with possible investors, including Waytena, proceeded. Waytena waited until R.A. Moog Inc. was on the ropes, then gained control on the cheap by assuming all the debt. His main interest was to obtain Bob’s name as figurehead. The plan was to phase out the prototype Mini D and ramp up production and sales of the production-engineered Sonic V.

But a funny thing happened. The Mini sold well, primarily due to the marketing efforts of David Van Koevering [and its superior sound]. The Sonic V [and Six] did not. The educational market did not develop, the wooden case was a clunk to transport, it lacked left hand performance controls, and the instrument did not sound as good as the Mini D. It also was severely limited by having only a single, simple, attack/decay MicroMoog-style envelope generator shared by both the VCF and the VCA.

Sonic Six Mark 1

In an effort to meet the market requirements the Sonic Five was repackaged in a suitcase clamshell for transportability and called the Sonic Six. This initial Mark 1 upgrade did incorporate a left hand pitch bend performance control - although awkwardly placed transversely. It was adequately transportable although there were some problems, such a slamming shut on the player’s hands, falling backwards off the music stand and suffering frequent failures due to inadequate support and flexing of the large PC boards. We called it the “Chronic Sick”. The “Samsonite synthesizer” also certainly suffered in appearance compared to the handsome Mini D. The initial Sonic Six still retained the original Sonic V diode-based VCF and VCA output circuitry and thus lacked the rich sound of the Mini D. Allegedly Reinagel had a hand in the Mark 1 repackaging job.

Sonic Six Mark 2

To address more of the deficiencies of the Sonic Six Mark 1 the synthesizer was upgraded to the Mark 2 version. Ben Luce tells me it was his father David Luce's first job when he came on-board the Moog Company. Dave addressed the mechanical difficulties (but not the fore/aft balance [an impossible task]. A vertically aligned two-wheel left-hand controller for pitch and modulation per the Mini D was added. The inadequate diode-based VCF was replaced with a patented Moog ladder filter and the VCA path was replaced with a three-stage design with tanh [hyperbolic tangent] sound enhancement distortion characteristics similar to the Mini D.

Research into the Mini has shown that the triple VCA was key to the Mini and sound character. Scott believes that the Mini was never matched in sonic character over the next 50 years because this triple VCA was unique to the Mini, but damn it, here was another example that no one was aware of staring him in the face. But even with these improvements the Sonic Six Mark 2, it did not sell well enough and eventually had to be phased out in favor of the Mini D.

Sonic Sound Chain

In 2018 Jim Scott and Ben Luce investigated the Sonic Six Mark 2 that [Tim Warneck of] Retrolinear had renovated for EMEAPP. An examination of the VCA circuitry by Jim showed that by rights the Mark 2 [Sonic Six] ought to have a sound quality equivalent to the Mini D fat sound. But why did it not? The reason soon became apparent. The Mark 6 sound chain was driven at a level to minimize tanh [hyperbolic tangent] VCA distortion. The Vintage Mini sound chain (as originally designed by me) is driven at 40 mV p-p for a single sawtooth at max mixer gain compared to only 12 mV p-p for the Mark 2.

Since distortion (and spectral enhancement) is proportional to the square of the drive, the Sonic Mark 2 was saddled with a beneficial distortion capability 1/12 that of the Mini D and thus produced a rather anemic sound. I, Ben and Tim [Warneck - owner, Retrolinear] made an easy mod to this machine (no front panel changes) to allow variable overdrive. All of a sudden the Sonic 6 Mark 2 was hung a set of balls! It sounded wonderful! Ben, who had become proficient with the Sonic 6 Mark 2 as a teenage keyboardist, could not keep his hands off of it for the next several days. This change was coupled with correction of a factory output wiring blunder. The modifications yielded what we termed the "SuperSonic". David Luce had made the mistake of not appreciating the importance of the very special sound processing characteristic of a heavily overdriven triple tanh-characteristic VCA.

At this point, let's spare a thought for Gene Zumcheck. Having (allegedly) fallen out with Bob Moog once before, he again found himself working alongside the man, and soon left the company. Once Zumcheck had departed for the second time, Moog [Music] decided to take the Sonic V and turn it into a Moog product. To do so, he [Moog Music] made just one significant change; he [Moog Music] returned to one of the rejected 1969 drawings for the Minimoog [Model D] (one that never made it, even as a prototype), and installed the Sonic V's circuitry and keyboard into this. He [Moog Music] then added a pitch-bend wheel and glissando control. The result was the Moog Sonic [Six, not "6."]

If you look at a picture of the Sonic V, you can see that Moog chose not to disguise the Sonic Six's origin. Indeed, the panels and facilities of the two instruments are all but identical. In some ways I find this quite surprising, because it's an open admission that the Sonic Six was someone else's instrument [" . . . open admission . . . " At no point did anybody at Moog Music try to "disguise" the fact that the Sonic Six was " . . . someone else's instrument." This implied *conspiracy theory* is pure hogwash!] Indeed, it looks and feels quite unlike any other Moog synthesizer. Fully integrated,

with the keyboard, controls and synthesizer circuitry built into a hinged ABS case, it is perhaps unlike any other synthesizer, period. (The EMS Synthi A and AKS are also built into an ABS case, but they both lacked a real keyboard so, for the purposes of this discussion, they don't count.)

Two Versions

In addition to changing the filter in later Sonic [Sixes,] it appears that Moog also changed the output panel. Early models offer 'High' and 'Low' audio outputs and a single switch that selects either the internal speaker system or the outputs. My own Sonic 6 [Six] (as described in the main text) offers headphone and line level outputs, plus two switches that allow you to select any combination of internal and external amplification.

The original "Mark 1" (my designation 2019) Sonic Six used the Sonic V VCF and VCA. Fred Reinagel had a hand in the conversion from the Sonic V.

Serial number 3000 and onward were modified by David Luce to incorporate the Moog ladder filter and to incorporate a three-stage VCA similar to the Mini D three-stage VCA. The last three dozen from 1264 to 3000 may also have had these changes implemented. Let us call the Luce upgrade the "Mark 2".

To clarify, 1264 is definitely Mark 1 and 1300 is Mark 2. Available records do not show if 1265 thru 1299 ever existed or what modification version(s) they were.

The Mark 1 Sonic Six can be quickly distinguished from the Mark 2 by the front panel nomenclature. The former is labeled "Sonic Six", the latter is labeled "Sonic Six Synthesizer". Also the left hand Mark 1 transverse pitch bend wheel was relocated to a fore-and-aft wheel in the Mark 2.

The Sonic 6 [Six]

When you open the case that houses the Sonic 6 [Six] you find the keyboard, performance controls and interfaces in the lower half, with the control panel and an integrated speaker system in the upper.

The four-octave keyboard is particularly generous, making the instrument as large as a small polysynth, but it allows you to make the best use of the Sonic [Six's] duophony (of which more later). To the left of this, you'll find the limited number of performance controls. Gone are the characteristic Moog dual pitch/modulation wheels, to be replaced by a single, transversely mounted pitch wheel. Above this, you'll find the master volume control and the portamento rate control.

Behind the keyboard lie two sets of interfaces: inputs to the right and outputs to the left. The left panel offers the main output (marked 'monitor') and a headphone output, together with three switches: power on/off, monitor on/off, and speaker on/off. The panel on the right provides an external signal input (with associated gain control), a generous complement of CV inputs for the pitch, filter cut-off frequency, and output gain, plus a trigger input on a Cinch-Jones socket marked 'Accessory'. But none of this gives you an idea about the idiosyncrasies of the Sonic 6 [Six]. To appreciate these, we'll have to take a closer look at the architecture itself...

Modulators, Oscillators & Other Signal Sources

Starting on the left of the main control panel, you'll find the Sonic 6's [Six's] twin low-frequency modulators. Named Waveform Gen X and Waveform Gen Y, each of these offers four waveforms (sawtooth, ramp, triangle and square) plus a Rate slider used in conjunction with either a Master frequency control or the Contour Generator. You can program the LFOs independently, and then mix

and balance their outputs using the Balance X/Y knob. There are few early monosynths that offer dual programmable LFOs, and even fewer that allow you dynamically to control their rates using an envelope generator... but dual, mixable, dynamic LFOs? Right now, I can think of only one (see “The Crumar Spirit” box later).

Moving to the right, we come to the oscillators, called Tone Generator A and Tone Generator B. Each of these offers sawtooth, triangle and pulse waveforms (the last with variable pulse width, but not pulse-width modulation), coarse tuning and fine-tuning. Underneath the panels holding these, there are secondary panels that contain the modulation options. For Oscillator A, these include modulation using the X/Y mix from the LFOs, plus the output from the contour generator. For Oscillator B, the inputs are the X/Y mix from the LFOs, plus the signal from Oscillator A (thus making the Sonic 6 [Six]a two-operator FM synth). Furthermore, Oscillator B offers keyboard scaling from zero to 100 percent, allowing you to play in micro-tuned scales such as quarter notes, or obscure avant-garde scales such as 17 and 19 notes per octave.

But that's not all. You can select the note priority that drives Oscillator A, choosing between low note, high note, and “off.” Since Oscillator B is always high-note priority, this means that you can play the Sonic 6 [Six] duophonically.

Moving another few inches to the right of the control panel, we now come to the Ring Modulator, the pink/white Noise Source, and the Source Mixer. The Ring Modulator offers two carrier inputs: Oscillator B and the external signal input. The modulator input can be either Oscillator A or the mixed X/Y output from the LFOs. Given that, at their fastest, the LFOs stray well into audio territory, this offers yet another flexible range of facilities, especially since you can use the oscillators' FM capabilities simultaneously with any of the four RM combinations available. The Mixer then allows you to mix the outputs from the oscillators (balanced using the Balance A/B control) with the output from the Ring Modulator, the Noise Source, and the untreated signal from the External Input.

As you can imagine, this is a hugely flexible package of features, and it makes the Sonic 6 [Six] a natural choice for all manner of weird sound effects and spacey noises. But let me put one myth to bed right now. I've read in numerous places, both on paper and on the web that, due to outrageous tuning instabilities, the Sonic 6 [Six] is unusable as a melodic synthesizer, and that it is useful only as a generator of weird and wacky sounds. This is a load of bovine manure. My Sonic 6 [Six] is in tune within seconds and, thanks to its temperature-compensated oscillator circuits, it remains so whether left on for a few minutes or a few hours. OK, I'll admit that the octave selector is slightly out on oscillator B, and that the scaling differs between 'A' and 'B' by perhaps one percent across all four octaves. However, this is no worse than many other vintage synths I own, and an hour spent with a small screwdriver should allow me to correct even these slight errors.

Indeed, my experience of the Sonic 6 [Six] suggests that it is among the most stable and reliable of the early monosynths, which may explain why Bob Moog used one as an educational aid when he toured the lecture circuit in the mid-'70s. [That’s not why Bob used the Sonic Six. Bob used the Sonic Six precisely because it DID have more synthesizer “functions” than the Minimoog, as he was appearing primarily as a teacher-lecturer showing how voltage controlled modules might function, and not as a performer. Bob Moog and I actually discussed this. Most performers favored the sound of the Minimoog. I was out in the field selling both. All the way from Australia to behind “the Iron Curtain!”]

The Minimoog Story

After Zumcheck's departure from R.A. Moog Inc., Moog employees Jim Scott, Chad Hunt and Bill Hemsath continued to encourage Bob Moog to develop Zumcheck's idea of an

integrated performance synthesizer. [Many people in The R.A. Moog group had "Zumcheck's" idea!"]

It's now long-forgotten but, without the determination of these three men, the company might have gone bust, consigning the Moog name to obscurity alongside other synthesizer pioneers of the mid- to late- '60s. Fortunately, before matters became quite that desperate, the team developed an integrated synth closely related to the modular System 10 (which itself had been co-developed by Zumcheck). Then, after building three prototypes, Scott, Hunt and Hemsath went into production (allegedly against Moog's explicit instructions not to) with the first batch of Minimoog Model Ds.

Consequently, I would like to propose two ideas that fly in the face of conventional wisdom: firstly, it would be fair to describe Zumcheck and Hemsath as parents of the Minimoog, ranking alongside Moog himself.

Gene's sole role was acting as a cheerleader, and there were many of those at R.A. Moog already.

If it had been left to Moog alone, the world's most revered monosynth might never have existed.

This is likely true, as Bob saw no advantages for a low-priced portable synthesizer! [Absolutely true!]

Secondly, co-designer Jim Scott (who developed the Minimoog's contour generators, VCF, VCA and other circuits) has gone on record to say that the excellence of the synth can be attributed to a series of electronic accidents and a healthy dose of serendipity-Indeed, when Moog and others later attempted to correct some of these faults, they found that the 'improvements' degraded the sound. Scott has even suggested that the classic sound of the Moog filter was an accident, a consequence of a circuit configuration needed to make it work at all.

It wasn't solely the Moog ladder filter–that is mythology! It was largely the VCAs distortion, although Ben Luce has proved to my satisfaction that the filter does play a role. But as we've seen above, the good distortion happens only when the entire sound chain after the oscillators/mixer is *overdriven.* I've probably heard more Minimoogs than anybody on the planet, as I sold them worldwide for years. And I quickly reported back to the plant when it was no longer sounding like a Minimoog (when the drive had been decreased). I've also owned a number of Moog Sonic Six synths, several of which *did* have that Moog ladder filter. None of those ever *remotely* sounded like a Minimoog! Finally, I've owned several ARP 2600 synths, some of which had the Moog ladder filter (ARP infringed), and none of those ever *remotely* sounded like a Minimoog either! What does one conclude? Presence of the Moog Ladder filter might *perhaps* be a necessary condition, *but certainly not a sufficient condition.* In any case, it's the level at which those circuits are driven that appears to be the critical factor.

Variations On A Theme In 'D'

All Minimoogs were Model Ds. However, ignoring minor modifications such as the colour and shape of the mod/pitch wheels, there was one area in which they changed considerably between 1970 and 1981. This was the design of the oscillators.

The first 299 [265] units, many of which were built before Moog's move to Buffalo, used all-discrete oscillators. In other words, there were no 'chips' in them. Although these units are the hardest to keep in tune, many players believe that they sound the best. (Maybe they do, but I'll sacrifice a little je ne sais quoi for pitch stability, any day.) The next 9000 or so used a newer design based on a chip called the 3046, while the last 3000 or thereabouts were based on a temperature-~~compensated~~ regulated (and therefore much more stable) Fairchild chip called the uA726.

The sounds of the three versions were subtly different, but in the late '70s and early '80s many players upgraded older Minimoogs by replacing the earlier boards with the later ones. Nowadays, analogue anoraks throw up their hands in horror at this, but when you're on stage in front of a few thousand people it's no good explaining that your synth has luvverly discrete oscillators when all your solos are horrendously out of tune.

But who introduced the uA726 to Moog synthesizers? Zumcheck, who based the Sonic V's oscillators upon this chip. Then, when Bob Moog [Actually, the Moog Company] relaunched Zumcheck's synthesizer as the Sonic 6 [Six], he [The Moog Company] retained the design. In other words, not only has Zumcheck's role [Gene had little or no role!] in the genesis of the Minimoog been swept under the carpet, but he was even responsible (if indirectly) for its last major upgrade! [" . . . swept under the carpet . . ." Once again, pure conspiracy theory. Gene had essentially no role in the Minimoog's development! See Scott below for the uA726 idea.]

The VCA & VCF

Next in the signal path, we come to the filter. Except that we don't. Unlike every other pre-patched (i.e. not modular) synth that I know, the Sonic 6 [Six] appears to present its VCA (or 'Articulator') before its VCF. If you think about it, there's no reason why this should not be a viable configuration, but it looks damn weird! [It was weird! There are actually a number of reasons why the VCF should precede the VCA, but this can't be explained in 25 words or less!] [For starters, you can get a much different sound if you put the beneficial distortion effect of the VCA ahead of the VCF. For better or worse the VCF will remove spectral components produced by the VCA.]

The VCA offers two signal paths: one whose gain is controlled by the Contour Generator, plus a switchable Bypass that appears to pass all the signal from the Source Mixer directly to the filter.

The Contour Generator itself is, however, the great weakness of the Sonic 6 [Six]. There are only two controllable stages — Attack and Decay (which would, in normal parlance, be called Attack and Release) — plus a two-position switch that selects between an AR envelope and an ASR ARP Odyssey 'trapezoid' shape. Given the Sonic 6's huge range of modulation capabilities, and the number of envelope destinations, you have every right to expect at least two full ADSR generators, but there it is... we've identified the Sonic 6's [Six's] Achilles heel.

Underneath the Contour Generator panel, you'll find the Trigger Input selectors, which offer keyboard triggering, and Gen X and Gen Y triggering (which operate regardless of the LFO waveforms selected). You can select and mix any combination of these to create strange, polyrhythmic effects — great. Unfortunately, once triggered, the Contour Generator will always complete its cycle, even when set only to Keyboard Triggering, and whether you hold a key or not. Sometimes useful for percussion synthesis, this can be a complete pain in the posterior when you use sounds that have a slow attack. You release the key, expecting the sound to enter its Release stage but it continues to swell, possibly in both volume and brightness. Not so great.

Penultimately, we come to the filter. Early Sonic 6s [Sixes] retained Zumcheck's diode ladder filter, but serial numbers above 1264 incorporated Moog's transistor ladder. Either way, the panel offered the usual control over cut-off frequency and resonance, with cut-off frequency modulation provided by the Contour Generator, the mixed X/Y output, and/or the keyboard (zero or 100 percent).

At maximum resonance, the filter will self-oscillate. However, on my unit (serial number 1496)

the Moog filter offers progressively less resonance at lower frequencies, to the point at which self-oscillation is no longer possible. This behaviour emulates that of my Minimoog, although to a more extreme degree. The similarity should come as no surprise — after all, this is one of the Sonic 6s [Sixes] with the traditional Moog filter.

"At maximum resonance the filter will self-oscillate . . . " The key issue here is how the emphasis feedback feature is calibrated. Sonic Six User Manual technique can produce a rather weak degree of feedback for the Mark 2, leading to self-oscillation fade out at lower frequencies. The MiniMoog calibration procedure results in a more robust feedback calibration for essentially the same circuit, resulting in a much wider oscillation range. The tradeoff is that the nominal unity gain of the Mini D VCF passband is reduced to about 0.75, instead of the nominal 1.00, leading to a somewhat reduced drive to the VCA (30 mV vs. 40 mV). The Mini calibration procedure also results in a small amount of residual regeneration (emphasis) even with the resonance control set to zero. This is evidenced by a small "tit" on the VCF sawtooth or square output waveform.

When we made the SuperSonic [hyperbolic tangent overdriven VCAs] modification, we calibrated the regeneration according to the MiniMoog procedure to achieve a wide range and reliable VCF self-oscillation.

The final 'panel' contains the Direct Output Mixer, which allows you to mix the untreated output from Oscillator A, Oscillator B, and the Ring Modulator directly into the final output. Since these signals are not modified or articulated by the VCA or VCF, they offer quite different tones to those provided by the conventional signal path. Indeed, if you base the main synthesized sound just on Oscillator B, and then add low-note-priority Oscillator A in the Direct path, you can not only play duophonically, but also (within limits) duo-timbrally. This was amazing stuff? in 1972.

Two Into One Will Go

I owe you an apology. This is because I claimed in an earlier Retrozone feature that the ARP Odyssey (released in 1972) was the world's first commercial duophonic synth. Unfortunately, this statement doesn't stand up to scrutiny because the Sonic 6, also built in 1972, is also duophonic.

At first look, that statement doesn't make sense — but let me explain. Remember that the Sonic 6 is, for the most part, a cosmetic rehash of the Sonic V. This means that the Sonic V, built in 1970, is almost certainly duophonic too, and if it is, it beat the ARP Odyssey to the punch by two years. (I have no way to check this. Maybe someone in SOS-land could write to tell me, one way or the other.) So, not only was I wrong to accord the 'First To Achieve Duophony' honour to ARP, but it now appears that neither ARP nor Moog can claim to have marketed the world's first duophonic synth. Yet again, Zumcheck seems to have been ahead of his time.

In Use

In addition to its weird architecture, the Sonic 6 [Six] hides a few tricks that you probably won't discover when you first play one. My favourite involves the Gen X/Y Balance control. As already described, this balances the outputs from the two LFOs prior to applying the summed CV to the oscillators, Ring Modulator, and filter cut-off frequency. What is not apparent, however, is that if you turn this knob fully anti-clockwise and click it to the 'off' position, Gen X is directed exclusively to Oscillator A and the filter, while Gen Y is directed exclusively to Oscillator B. This is fantastic, allowing you to control the depth, waveform and rate of modulation independently for each oscillator. The richness of sound thus obtained has to be heard to be believed.

A second bonus concerns the implementation of the Glissando. When the keyboard tracking of

Oscillator A is set to 'High Note', glissando affects both oscillators equally, producing the portamento effect that you hear on almost all other monosynths. However, if you set the tracking of Oscillator A to 'Low Note', glissando does not affect it. If you then play the Sonic 6 [Six] monophonically, Oscillator B glides between notes, while Oscillator A jumps directly to the new pitch. This is an uncommon effect, but very expressive.

The third bonus, for me, concerns the filter, which tracks the keyboard perfectly. When self-oscillating, it produces a gorgeous, delicate wave that is slightly more complex than a pure sine wave (and therefore more interesting) but which retains much of the sonic purity and roundness of the sine. Played with a little glissando, a little vibrato, and a moderate Attack and Release contour on the VCA, this is a superb 'lead' patch that would be perfect for much of today's New Age twiddling.

One wonders how this sound might change if the Mark 2 [Sonic Six] VCF regeneration were calibrated like the Mini . . .

Hang on a second... if the VCA precedes the VCF, it should not be possible to articulate the self-oscillating filter. This means that that the signal flow depicted on the control panel is wrong! I can think of only one acceptable excuse for this: because the controls are mounted directly onto the synthesizer boards, it may have been necessary for electronic reasons to have the VCA components to the left of the VCF.

The Sonic V and Sonic Six Mark 1 put the VCA ahead of the VCF. [David] Luce rectified this oddity by putting the two functions in normal order, VCF before the VCA in the Mark 2. However, the Mark 2 front panel was not updated to reflect this change and depicts the two functions in reverse of the actual order.

But to concentrate on the niggles is, perhaps, to miss the point. In 1970 (and in 1972), this was a remarkable design, and both the Sonic V and the Sonic 6 [Six] deserved greater recognition than they ever obtained. [Musicians voted with their ears–and their wallets. It was the marketplace that determined which instruments " . . . deserved greater recognition . . ." Again with the conspiracy theories! Trust me, I was trying like hell to sell those Sonic Sixes as we had 'Sonic Six mountain' back at the Moog plant, a huge pile of instruments that had not sold. In fact, I've joked that I can't go back to Australia because my picture is on so many of their post office walls! I did sell quite a few Sonic Sixes there, as Australia had several ongoing educational projects for which the Sonic would be appropriate.]

The Minimoog Story

After Zumcheck's departure from R A Moog Inc., Moog employees Jim Scott, Chad Hunt and Bill Hemsath continued to encourage Bob Moog to develop Zumcheck's idea of an integrated performance synthesizer. It's now long-forgotten but, without the determination of these three men, the company might have gone bust, consigning the Moog name to obscurity alongside other synthesizer pioneers of the mid- to late- '60s. Fortunately, before matters became quite that desperate, the team developed an integrated synth closely related to the modular System 10 (which itself had been co-developed by Zumcheck). Then, after building three prototypes, Scott, Hunt and Hemsath went into production (allegedly against Moog's explicit instructions not to) with the first batch of Minimoog Model Ds.

Consequently, I would like to propose two ideas that fly in the face of conventional wisdom: firstly, it would be fair to describe Zumcheck and Hemsath as parents of the Minimoog, ranking alongside Moog himself. If it had been left to Moog alone, the world's most revered monosynth might never have existed. Secondly, co-designer Jim Scott (who developed the Minimoog's contour generators) has gone on record to say that the excellence of the synth can be attributed to a series of electronic accidents and a healthy dose of serendipity-Indeed, when Moog and others later attempted to correct some of these faults, they found that the 'improvements' degraded the sound. Scott has even suggested that the classic sound of the Moog filter was an accident, a consequence of a circuit configuration needed to make it work at all.

This is where Mr. Gordon really goes off the rails, making assertions that have absolutely zero basis in fact! As he does in spades when he puts forth all those wild conjectures regarding the lineage and development of the Crumar Spirit. I have answered those notions about the Crumar Spirit elsewhere on this site.

Gene Zumchak had absolutely nothing to do with the Minimoog, except possibly act as a *cheerleader* to the idea of a portable voltage controlled instrument, but there were many of those at Moog Music who held the same belief at the time! Let's allow Jim Scott to answer this:

The Minimoog Story (sidebar)

True journalistic semi-fiction mixing fact with surmises. In late 1969 the entire management and engineering staff recognized the need for a live performance axe – except our founder and president [Bob Moog]. This was the case when I came on board 15 Sept 1969. The vocal one among us was point man Zumchak, who lacked a bit in diplomacy, and who argued the case with the boss (who was not buying).

Hemsath, always the loner, quietly built the A Model prototype on his own initiative, on his own time, using mostly cast-off components, without any official sanction, and without saying what he was up to. Wordlessly it just appeared as a finished product on a table outside the engineering department some time before Thanksgiving 1969.

Our associated musicians [Chris Swansen, Jonathan Weiss, David Borden–yes, they had ears] loved it and began using it in performances. It should be noted that Zumchak's Modular Synthesizer 10 in fact was preceded by the Bob Moog Model 1, ["P" for portable in tolex cases, and "C" for consoles in walnut cases] the module complement which appears in the 1967 Moog price list. The Model 10 is a Model 1 squeezed into a single portable case. Bill Hemsath recognized that this complement of functions constituted an oft-replicated "voice" and used this as the basis of the Mini.

With the urging of General Manager John Huzar, Hemsath with the assistance of Bob Moog and Chad Hunt then built the two B Models more or less in the spring of 1970. I was not involved. The B Models were intended as concept instruments for a proposed possible production performance monosynth. I think Bob viewed them a bait for a possible investor who might want to leave the Trumansburg operation intact as an R & D facility - and to have any mass-produced instrument produced elsewhere.

The development of a production model kicked off about 1 July 1970 with me brought on the project as Project Leader. The design team included Moog, Hemsath, Hunt and me. We produced four C Model hand-wired prototypes as demonstrators and for evaluation by musicians. Moog ordered 10 more hand-wired C-Models to be built Nov/Dec 1970. The entire staff with the blessing of the General Manager (not just us engineers) disobeyed orders and in Bob's absence (on a road trip) built the next 10 using production style printed circuit boards. The circuitry was nearly identical to that of the Model C. The D Model was thus born supposedly as a prototype.

Zumchak did not push for an instrument based on the Synth 10. Note that the architecture of the Sonic is uniquely Gene's and not at all like the Mini. He was not involved in the Mini A Model. Moog was pushed into development of the Mini by his ENTIRE staff. The Mini would absolutely certainly not have been developed if Bob had been left to his own devices. However, Bob was an active member of the team and enthusiastically contributed many ideas, such as the left-hand controller and the hinged front panel, and he designed the vintage Trumansburg VCO. Nonetheless he was convinced the Mini had no place in the market. Jim Scott designed most of the rest of the circuitry. Hemsath designed the power supply. Hunt designed a couple of auxiliary circuits such as the modulation mixer amp.

Hemsath, again on his own initiative, designed and built an alternative but more complex VCO PC board, which initially was not adopted. Both the Moog and the Hemsath VCO were developed more or less simultaneously. Due to poor implementation of a pretty good design, Moog's VCO exhibited poor pitch stability and subsequently was supplanted by a modified version of the more stable Hemsath VCO. While Moog's VCO was salvageable by installing higher quality resistors in critical locations, and was cheaper to manufacture, it did suffer from one deficiency in that it was inaccurate at the highest pitches. The Hemsath VCO incorporated a compensation feature of his invention to bring the high end into tune. Only 237 Moog VCO's were built.

Some more baloney: The "accident" producing the magic Mini sound in fact did not involve the VCF. The secret ingredients were the VCAs, which employed three-stages imparting hyperbolic tangent (tanh) distortion at each stage. This was Bob's 1965 Modular 902 VCA which Jim Scott heavily modified and repurposed to use in the Mini. The key factor was Jim's decision to heavily overdrive the VCA to ensure good signal-to-noise level performance. The *unintended* consequence of the resultant beneficial distortion was the spectral enhancement that produced the famous "fat sound".

Epilogue

When people tell the story of Moog synthesizers, there are many names that appear time and again. There's Bob Moog himself, of course. You're also likely to hear the names of Tom Rhea,

Dave Van Koevering, and Bill Waytena (who almost certainly saved Moog from extinction). And, if you're researching the development of the Minimoog, you will probably encounter the names of Jim Scott, Bill Hemsath and Chad Hunt.

But what of Gene Zumcheck? How many of us can hold our hands up and say that we fully appreciate his contribution to synthesis? Not many, that's for sure.

This is not surprising. Bob Moog doesn't mention Zumcheck's name when interviewed for reference books such as Mark Vail's highly regarded Vintage Synthesizers. Neither does Peter Forrest in his excellent A to Z Of Analogue Synthesizers. Forrest merely says: "Whoever designed the Sonic V deserves praise: one of the earliest portable synths, it was good enough to avoid major reworking when Moog turned it into the Sonic 6." [In fact, the Sonic Six required a great deal of “reworking” from the Sonic V version. Fred Reinagel played a major hand in the electronic design, and David Luce played a large role in the improved mechanical design, and likely tweaked the electronic design as well.] Yet it was Zumcheck who —before the development of the Minimoog — urged Moog repeatedly to design an integrated synthesizer. It was Zumcheck who designed the Sonic V (and therefore the Sonic 6 [Six]) [Actually both the Sonic V and the Sonic Six had mixed parentage, see both above and below], and it was Zumcheck who introduced the uA726 chip that Moog Music later adopted for its own oscillators. (See 'Variations On A Theme In 'D'' box.) Likewise, Zumcheck's contribution to duophony seems to have been forgotten.

Wrong in many dimensions. Who designed the Sonic Six? Was it not primarily Fred Reinagel? I was there when he came to the Moog plant in Williamsville, NY week after week. If he didn’t get a check from Bill Waytena that week, he would not have come back the next week! If you had wanted to credit Gene Zumchak, you might have mentioned that he designed the Model 960 Sequencer, for example. The other claims regarding Gene Zumchak’s contributions are worse than “dubious.”

> But who introduced the uA726 to Moog synthesizers? Zumcheck, who based the Sonic V's oscillators upon this chip. Then, when Bob Moog relaunched Zumcheck's synthesizer as the Sonic 6, he retained the design. In other words, not only has Zumcheck's role in the genesis of the Minimoog been swept under the carpet, but he was even responsible (if indirectly) for its last major upgrade!

Zumchak and Fred Reinagel designed the Sonic V. Probably analog designer Reinagel came up with the idea of using the uA726 heated dual transistor, not digital designer Zumchak. We could ask Reinagel or [Ron] Folkman about this. And the duophonic patent was issued to Reinagel and Zumchak. The Mini Cheektowaga VCO (last 3000 Buffalo production units) did use the uA726 device but it did not use the Sonic circuit. The Sonic used the two transistors in the package bare-assed and separately for the two oscillator exponentiators. Latter day Mini Buffalo production used both transistors in the package for a variation of the two-transistor exponentiator pioneered by Alan R. Pearlman [ARP}, Jim Scott, Bob Moog and Bill Hemsath ca 1965-1970.

So, despite the huzzahs for Gene in the “Variations On A Theme In ‘D’” sidebar, all Gene really did (if indeed it was his doing) was to identify a component that was used in a circuit Gene never thought of (the Moog exponentiator).

The original Sonic diode filter was not a significant contribution to electronic music and was replaced by the Moog ladder filter for the Mark 6.

So, when we tell the story of Moog synthesizers — indeed, when we tell the story of all analogue synthesizers — perhaps we should talk a little bit less about Bob Moog, a little bit less about ladder filters and modular synthesizers, and somewhat more about Gene Zumcheck. Wherever you are now, Gene, well done — and thank you. [I have no clue where Mr. Reid got such ideas about Gene Zumchak's role in development of either the Minimoog, or particularly the Crumar Spirit. No artifacts nor any established written documents support Reid's notions regarding either instrument's development. The preceding sentence ends with a period. Please consider this a *full stop!* Also, not to forget, Jim Scott kept meticulous Logbooks throughout his career that directly contradict Reid's guesswork! Finally, see my comments re development of the Crumar Spirit in a separate PDF on this same drtomrhea.com website.]

Commentary by Jim Scott in red (September 2023). Obvious incidental corrections by Tom Rhea (September 2023) with Rhea's comments in blue.