

WHAT MY MUSICAL INSTRUMENTS HAVE TAUGHT ME

*I've spent my life working on virtual reality—but my instruments have
revealed the real world.*

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Photograph by Michael Turek

It started after my mother died. She was a concentration-camp survivor—a prodigy concert pianist in Vienna who was taken when she was only a girl. She taught me the piano by holding her hands over mine, bending my fingers into arches above the keys. When I was just a boy, she died in a car accident. Afterward, I was both boundlessly angry and attached to the piano.

I played it with extreme force, sometimes bleeding onto the keys. I still feel her hands when I play. I feel them even more when I'm learning a new instrument.

As I write this, on a laptop in my kitchen, I can see at least a hundred instruments around me. There's a Baroque guitar; some Colombian *gaita* flutes; a French musical saw; a *shourangiz* (a Persian instrument resembling a traditional poet's lute); an Array mbira (a giant chromatic thumb piano, made in San Diego); a Turkish clarinet; and a Chinese guqin. A reproduction of an ancient Celtic harp sits near some giant penny whistles, a tar frame drum, a Roman sistrum, a long-neck banjo, and some duduks from Armenia. (Duduks are the haunting reed instruments used in movie soundtracks to convey xeno-profundity.) There are many more instruments in other rooms of the house, and I've learned to play them all. I've become a compulsive explorer of new instruments and the ways they make me feel.

I keep a small oud in the kitchen, and sometimes, between e-mails, I improvise with it. Ouds resemble lutes, which in turn resemble guitars. But where a guitar has a flat back, an oud has a domelike form that presses backward against the belly or chest. This makes playing one a tender experience. You must find just the right way to hold it, constraining your shoulders, moving mainly the smaller muscles below the elbows. Holding an oud is a little like holding a baby. While cradling an infant, I feel pretensions drop away: here is the only future we truly have—a sacred moment. Playing the oud, I am exposed. The instrument is confessional to me.

But that's not how all players experience their ouds. The most famous oud player of the twentieth century was probably the Syrian-Egyptian superstar Farid al-Atrash, who was both a respected classical musician of the highest order and a pop-culture figure and movie star. (Imagine a cross between Jascha Heifetz and Elvis Presley.) His playing was often crowd-pleasing, extroverted, and muscular. I have an oud similar to one Atrash played; it was created by a member of Syria's multigenerational Nahat family, whose

instruments are often described as the Stradivariuses of the oud world. In the nineteen-forties, my Nahat was savaged by a notorious Brooklyn dealer who tried to claim it as his own by covering the original label and marquetry. Later, an Armenian American luthier tried to remake it as an Armenian instrument, with disastrous results. After I bought the oud out of the attic of a player who had given up on it, two remarkable luthiers restored it, and the oud started to speak in a way that possessed me. Listeners notice—they ask, “What is that thing?”

Nahat ouds can be especially big. My arms have to travel more in order to move up and down the longer neck; the muscles around my shoulders become engaged, as they do when I’m playing the guitar. Moving this way, I become aware of the world beyond the small instrument I’m swaddling; I start to play more for others than for myself. The cello also makes me feel this way. You have to use your shoulders—your whole back—to play a cello. But cellos summon a different set of feelings. Playing one, you’re still bound up in a slightly awkward way, bent around a vibrating entity—not a baby, not a lover, but maybe a large dog.

The khaen, from Laos and northeastern Thailand, is the instrument I play the most in public. It’s a mouth organ—something like a giant harmonica, but with an earthy, ancient tone. Tall bamboo tubes jut both upward and downward from a teak vessel, angling into a spire which seems to emerge, unicorn-like, from the forehead of the performer. I first encountered one as a teen-ager, in the nineteen-seventies, during a time when I was exploring Chinese music clubs in San Francisco. These were frequented mainly by older people, and often situated in the basements of faded apartment buildings. The khaen isn’t Chinese, but I noticed one resting against a wall in a club and asked if I could try it. As soon as I picked up the khaen I became a rhythmic musician, driving a hard beat with double- and triple-tonguing patterns. The old men applauded when I finished. “Take it,” a woman holding an erhu said.

Later, I learned that my instant style was completely unrelated to what goes on in Laos. It emerged, I think, from how the khaen works with one's breathing. On a harmonica, as on many instruments, the note changes when you switch between inhaling and exhaling—but on a khaen, one can breathe both in and out without changing pitch. Breathing is motion, and so the khaen and its cousins from Asia, such as the Chinese sheng, are liberating to play. I've been lucky enough to play khaen with many great musicians—with Jon Batiste and the Stay Human band on “The Late Show with Stephen Colbert,” for instance, and with Ornette Coleman. When I played the khaen with George Clinton and P-Funk, Clinton stood facing me, leaning in until we were just inches apart; he widened his eyes to make the channel between our beings as high-bandwidth as possible, breathing ferociously to transmit the groove he was improvising. It was the most physically demanding performance of my life.

If playing the khaen turns me into an extroverted athlete, then the xiao—which is held vertically, like a clarinet or an oboe—invites me to explore internal dramas. This isn't just a mind-set but a physical sensation: while playing xiao I feel a rolling movement in the air just behind my upper front teeth, and a second area of resonance in my chest, and I seem to move these reservoirs of air around as I use the instrument. I'm not the only one to have this kind of sensation: singers often say that they experience air in this way, and flute teachers I've known have talked about “blue” or “yellow” air flows. I've had long conversations with wind players about how we seem to be painting the flow of air inside our bodies. I have to suspend my skepticism when this sort of talk starts—I don't think we're really doing what we describe, but I do think we're describing something real. It's possible to shape tone by adjusting the mouth, tongue, lips, jaw, throat, and chest. When I find my tone, I even feel the presence of a structure in the air between my lips and the flute—a tumbling, ineffable caterpillar, rolling rapidly on its long axis. The caterpillar collaborates with me, sometimes helping, sometimes pushing back, and by interacting with it I can explore a world of tone.

Did the xiao players of the past perceive invisible caterpillars like mine? Maybe they did. Xiaos have come in many shapes and sizes over the centuries, but, judging by the illustrations that have been preserved, they've all been recognizably xiao. On the other hand, there are many ways to play a flute. Perhaps xiao notes used to end in elegant calligraphic rises; maybe the breath was emphasized so that the sound of the flute seemed continuous with nature; or possibly ancient xiao tones were lustrous and technical, with perfect stability. Perhaps the sound that xiao players sought was deceptively transparent but filled with little features, or maybe they were show-offs, playing high, fast, and loud. These descriptions fit contemporary flute-playing styles, and it seems possible that historical styles resembled them—or not.

In recent years, a heightened spirit of experimentation in xiao-building has developed. Most of the experiments have to do with the shape of the blowing edge—the place where one edge of a flute's tube has been thinned, forming a tiny ridge that's positioned against the bottom lip to receive the breath. At the blowing edge, the air alternately flows more to the inside or the outside of the flute. This oscillation radiates as sound. Flutists of all cultures are vulnerable to debilitating fascinations with the tiniest design choices in blowing edges and the nearby interiors of their flutes. In Taiwan, a small cult has arisen around the idea of combining an outside cut in the form of a letter “U,” which is typical of some schools of xiao design, with an inside form that's more like a “V.” Debates about the new cut run rampant in online forums.

After reading some of them, I finally ordered a flute with the new cut. (That I could do this so effortlessly made me feel momentarily better about how the Internet has turned out so far.) When I played my “U”/“V” xiao for the first time, I made the futile blowing sound familiar to beginning flutists. Eventually, though, I managed a few weird, false notes. I was surprised but also delighted. Some of my favorite moments in musical life come when I can't yet play an instrument. It's in the fleeting period of playing without skill

that you can hear sounds beyond imagination. Eventually, I cajoled the caterpillar and found a tone I love, solid yet translucent. When that happens, the challenge is remembering how to make those fascinating, false notes. One mustn't lose one's childhood.

I'm a computer scientist by profession, and I started travelling to Japan at the beginning of the nineteen-eighties, when I was developing the first virtual-reality headsets and searching for business partners and technical components. I was surprised to find few young people there interested in traditional Japanese music. Precious and playable antique instruments like the shakuhachi, a traditional bamboo flute, could be bought at flea markets for less than the price of breakfast—and they were being snapped up not by Japanese students but by young Westerners who worshipped the remaining teachers. Meanwhile, interest in European classical music, which was declining in the West, was growing in Japan. I met many Japanese musicians who found Mozart as appealing as the Beatles, and who played violin and piano along with rock and roll. In Western countries, the social institutions that kept classical music alive—conservatories, instrument builders, teachers, contests—were being sustained by an influx of stunning musicians from Asia. A kind of cultural trade was taking place.

My experiences studying music in Japan were often astonishing. I chased down a teacher who claimed to be the holder of an ancient Buddhist shakuhachi tradition that had been suppressed by the mainstream musical world; his lessons were fused with a tea ceremony. I met another teacher who would only accept a student who could walk into the forest and choose a stalk of bamboo that, when it was cut down, would turn out to be in tune as a flute. (He gave me only one chance to get it right, and I failed.) In one of the main shakuhachi “lodges” in Tokyo, I came across a culture of male-dominated locker-room talk, in which some styles of playing were approved as sufficiently macho while others were denigrated as “gay.” Much of what I encountered startled me—it didn't reflect what I'd read in books back in

America about the shakuhachi.

Music operates on a plane separate from literature, and a lot of information about it isn't written down. Most of the world's compositions were never notated, and what was written down is often minimal; although scores do exist for very old Chinese music—some of the oldest are for the noble guqin, a kind of zither—they amount to mnemonic devices, lists of strokes and playing positions. The earliest European scores are similar, with lists of notes. What we now call “early music” is largely a modern stylistic invention. I tend to learn the rudiments of my instruments and then develop my own style; I'm an eternal amateur. But I console myself by noting that there are very few musical conservatories structured enough to preserve musical styles over long periods of time. We can study how Bach's music might have sounded, or how the shakuhachi was actually played, but we can never really know. What would it have sounded like to be at court in ancient Egypt, Persia, India, China, Greece, Mesopotamia? The truth has been lost to time.

The exquisite skills involved in making instruments can seem to hover just beyond the edge of scientific understanding, and can easily be lost when war, plague, and famine break the chains linking masters and apprentices. And yet the traditions of a lost musical culture can sometimes be revived. Modern instrument makers can copy preserved examples of old instruments, or even work from illustrations. In the case of the xiao, much was lost through the centuries, and then again in the Cultural Revolution—but xiaos are small and easy to hide. Some musicians are said to have buried them in secret locations, in hopes of escaping Mao Zedong's attempts to engineer culture from scratch. This complex history means that, today, there are contrasting contemporary approaches to playing the xiao. Some players see learning and performing with the instrument as a spiritual quest to reconnect with the past; others play what sounds to me like a Hollywood composer's idea of Chinese music from the early twentieth century—a musical genre that's aged surprisingly well. There's no verifiably authentic way to play such an ancient instrument.

As a technologist, my work has often focussed on the creation of interactive devices, such as head-mounted displays and haptic gloves. It's sobering for me to compare the instruments I've played with the devices that Silicon Valley has made. I've never had an experience with any digital device that comes at all close to those I've had with even mediocre acoustic musical instruments. What's the use of ushering in a new era dominated by digital technology if the objects that that era creates are inferior to pre-digital ones?

For decades, researchers have been attempting to model acoustic instruments with software. Simulated saxophones and violins can sound impressive but only within an artificially constrained frame. Listen to one note at a time and the synthetic instruments sound good. Connect the notes together and the illusion fails. This may be because the experience of interacting creatively with such models is sterile, vacant, and ridiculous. One is usually clicking on little dots on a screen, or pushing buttons, or—in the very best case—adjusting variables with physical knobs and sliders. From a commercial point of view, this doesn't make simulated instruments useless; embedded in the mix, splashed with reverb and other effects, they sound just fine. But physical instruments channel the unrepeatable process of interaction, a quality lost with modern production technology.

Human senses have evolved to the point that we can occasionally react to the universe down to the quantum limit; our retinas can register single photons, and our ability to sense something teased between fingertips is profound. But that is not what makes instruments different from digital-music models. It isn't a contest about numbers. The deeper difference is that computer models are made of abstractions—letters, pixels, files—while acoustic instruments are made of material. The wood in an oud or a violin reflects an old forest, the bodies who played it, and many other things, but in an intrinsic, organic way, transcending abstractions. Physicality got a bad rap in the past. It used to be that the physical was contrasted with the spiritual. But now that we

have information technologies, we can see that materiality is mystical. A digital object can be described, while an acoustic one always remains a step beyond us.

Today, tech companies promise to create algorithms that can analyze old music to create new music. But music is ambiguous: is it mostly a product to be produced and enjoyed, or is the creation of it the most important thing? If it's the former, then being able to automate the production of music is at least a coherent idea, whether or not it is a good one. But, if it's the latter, then pulling music creation away from people undermines the whole point. I often work with students who want to build algorithms that make music. I ask them, Do you mean you want to design algorithms that are like instruments, and which people can use to make new music, or do you just want an A.I. to make music for you? For those students who want to have optimal music made for them, I have to ask, Would you want robots to have sex for you so you don't have to? I mean, what is life for?

Much of the music we enjoy today makes use of audio loops, by means of which a note can be repeated with absolute precision. Because of my work with computers, I had early access to looping tools, and I was able to play around with loops earlier than most musicians. At first, the techniques didn't speak to me; music is about change, I thought, while loops are about artificially preventing change. When so-called minimalist composers—Philip Glass, Terry Riley—ask musicians to play the same phrases repeatedly, what emerges from this technique isn't repetition but an exquisite awareness of change: using a traditional, physical instrument, each repetition reflects your breath, your pulse, the weather, the audience, the light, bringing subtlety into consciousness. My understanding of loops shifted when hip-hop appeared. Here was a genre that was often angry, often a protest—the use of loops could evoke the strictures a rapper raged against. Some musicians now make their loops a little blurry, as if to suggest impermanence. For many people, of course, loops have become so commonplace that it's hard to perceive them as a contrast to anything else.

In my own musical life, I prize the edge of chaos; that which cannot be repeated. I usually don't record myself when I play alone; I don't want to trick myself into a false mentality that lives outside of time, as if we weren't time's prisoners. I want to send music out into the universe, not into a computer's memory. As crazy as it is to learn to play a multitude of instruments, my madness is the opposite of the loop. I'm often asked if I've learned all these instruments in order to make a sample library, or if I'd be willing to have someone come to the house to make such a library. Though I offer positivity from afar to musicians who like samples, I am travelling in a different direction.

If you work with virtual reality, you end up wondering what reality is in the first place. Over the years, I've toyed with one possible definition of reality: it's the thing that can't be perfectly simulated, because it can't be measured to completion. Digital information can be perfectly measured, because that is its very definition. This makes it unreal. But reality is irrepressible.

I sometimes dwell on these ideas when I play the piano. A piano is essentially a row of keys, plus some pedals. Once a key has been depressed, a mechanism sends a felt hammer flying toward a string, which is not in direct contact with the key. In theory, this means that a piano played without the damping pedal ought to be abstract, like an electronic keyboard. The only information the hammer seems to convey from a key to a string is a single number—velocity. That's also how much information a key press communicates in an electronic keyboard. And yet the experience of playing an acoustic piano, and of listening to one, is that more is being conveyed. When pianists trade off on the same instrument, they perform with individual touches and sounds. Pianos are somewhat abstract devices that have transcended abstraction.

My fondest hope for computing is that digital devices will become as much

like pianos as possible. But the subtlest qualities of analog instruments are hard to study, in part because the controls necessary to make studies rigorous risk obscuring important elements of musical experience. There have been many studies comparing old and new violins, for instance, or flutes made of different metals, in which a player is hidden behind a screen and listeners are asked to identify which instrument is being played. The problem with this approach is that the difference between a good instrument and a great one could inhere in the player's experience, rather than in the external sound. If an instrument inspires a musician, then the music will be more meaningful, even if listeners can't distinguish the sound of one instrument from another. Music is an interior art before it becomes exterior.

For me, the piano has an interior aspect. The piano is one of the few instruments that's bigger than you. Playing it, *you* are the baby: strike as much as you like, it remains the same. After my mother died, I became obsessed with fast arpeggios, and I zoomed between the extremes of the keyboard; I was also drawn toward the American-Mexican composer Conlon Nancarrow, who wrote superhuman piano music for player pianos, using hand-punched player-piano rolls. When I was a teen-ager, I often hitchhiked from New Mexico to visit him in Mexico City. I was determined to play as fast as the pianos automated by Conlon; his machines, in their unreality, were a flight from human frailty and trauma. I emulated them by challenging them in my own piano playing. In my fury, the piano became a chunk of reality to obliterate, though quixotically. You can caress a piano or attack it, be loud or soft, become proficient or not, make as much beauty as you can or flail in chaos—the instrument will most likely endure beyond you.

Decades have passed since that time. Today, I love to have musicians over to my house, where we can combine different instruments to see what happens. The joy that transpires when things go well is multilayered. There is the pleasure of connection with other people, and there is also the happiness of finding a new little corner of aesthetic interiority together. Music can conjure a new flow, a new pattern, a new flavor, between and inside people. And

playing sufficiently obscure instruments forces a different approach to music. How can you be competitive about raw skill, or get into some other macho trap, when the task at hand is so esoteric? Who is to judge the winner in a contest that must invent itself over and over? When music made collaboratively with other musicians goes right, I feel a budding, rising warmth and comfort. Is this my mother smiling on me? Or maybe it's me, smiling on her. ♦